

HANDWORK IN A RURAL SCHOOL.  
BOYS DISPLAYING WOODWORK; GIRLS DISPLAYING RAFFIA AND CARDBOARD WORK.

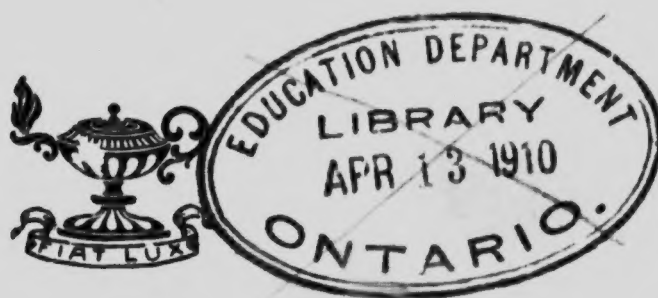
# EDUCATIONAL HANDWORK

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BY

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FREDERICTON, N.B.



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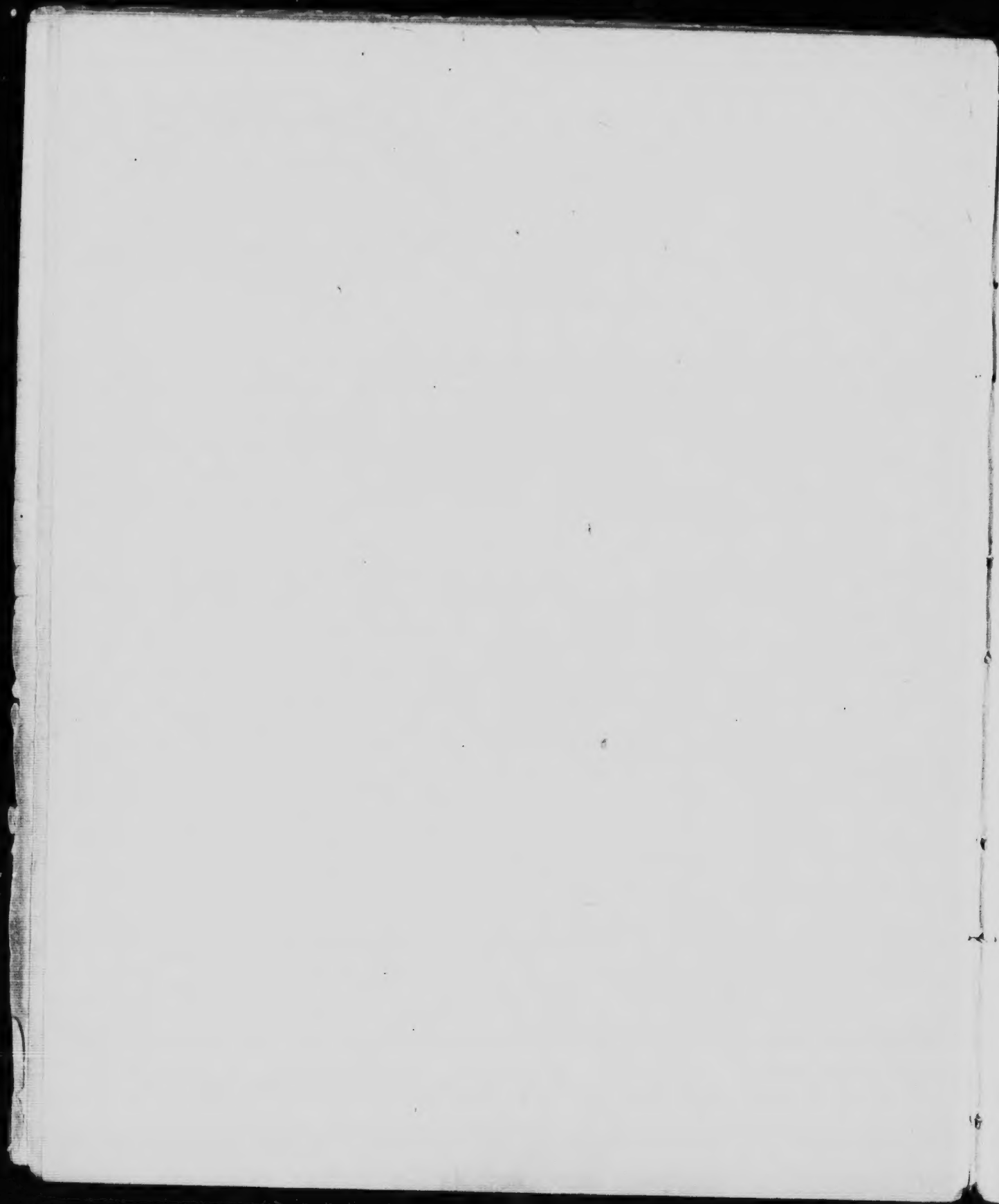


## FOREWORD

EDUCATIONAL HANDWORK helps to preserve and develop the love of manual labor and to foster the habit of being happy at lessons in school. These experiences become immensely valuable in later years also, for all the tasks and opportunities of life. This work is prepared by a teacher who has proven his merit by ten years of leadership in educational handwork in schools in Canada. It can not be "the final word" on such a subject. The children, as representing the possibilities of the race, are themselves only in the making; and the schools at their best are only at the beginnings of adequate service. But this is a contribution of real value to our present needs. Its scheme provides for progressive training during the early years in three fine factors in good education,—observing correctly, thinking clearly towards expression in deed and word, and managing economically. I welcome it as another aid to teachers in their peerless calling.

JAS. W. ROBERTSON.

OTTAWA, ONT.



## INTRODUCTION

THE chapters of this book which deal with the subject of Cardboard-cutting and Modelling were originally published as a series of articles in the "Educational Review," of St. John, N. B. The articles were prepared by the author in response to a demand for some form of Manual Training which could be adopted by teachers in small schools who were unable, from various causes, to undertake any of the more elaborate forms requiring special equipment in the school and prolonged training on the part of the teacher. The course outlined serves also as a good preliminary training for pupils in the grades immediately below those in which Manual Training in Wood-work, Metal-work, Household Science, Dress-cutting, etc., form a part of the school course.

The universal and growing interest in Handwork as a branch of general education, has, however, led to a demand for some form of "Hand-and-Eye Training" for pupils of all grades, from the Kindergarten to the High School. A number of books dealing with the various branches of such work have been published, but the want of a book, giving within the compass of a single volume, a course suitable for pupils of all school ages, has long been felt. The present volume is an attempt to meet this want, and to that end a scheme of work has been devised, comprising: Paper-folding; Paper-cutting and Mounting; Pattern-work and Designing with coloured papers, embracing a simple introduction to the study of colour; Constructive work in paper; Cardboard-cutting and Modelling; the latter including chapters on the construction of a set of type forms of geometrical solids and on the application of cardboard modelling to the study of Descriptive Geometry; and a chapter on Raffia work.

Each course outlined is merely a suggestive one, but it is hoped that thoughtful teachers may find sufficient within the limits of this volume to enable them to introduce some or all of the several branches of the subject as herein considered. If a beginning be made, the ingenuity and inventive skill alike of teachers and pupils will enable each branch to be carried far beyond the exercises given in these pages. This is especially true of the design and pattern work, the scope for originality of thought and execution being practically unlimited in this interesting and attractive form of Hand-and-Eye Training.

The author is greatly indebted to Mrs. S. B. Patterson, of the Kindergarten Training School at Truro, N.S., for many valuable suggestions and practical help in the revision of the chapters on the Primary work. The advanced portion is chiefly the result of the author's experience as a teacher and organizer of Manual Training in the schools of England and Canada.

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# EDUCATIONAL HANDWORK

## CHAPTER I

THE time has passed when the necessity of providing for the training of the hands of the children in our schools had to be insisted on.

The recognition of the fact that the education of a child is defective unless it provides for the training of all his faculties—intellectual, moral and physical—is now universal. The great importance attached to “practical” work by all sorts of educators is an evidence of this, and from the Kindergarten to the University laboratory the principle of “learning by doing” is everywhere applied.

The training of the hand in childhood has been found to be of immense benefit as a means of general culture of the faculties. Eye, hand, head and heart are engaged, and the results fully justify the expectations of the advocates of this form of school work.

The acquisition of dexterity and skill of hand; the training of the eye to a sense of form and beauty; the formation of habits of accuracy, order and neatness; the inculcation of a love of industry and of habits of patience, perseverance and self-reliance, are some of the results which may be claimed as peculiarly belonging to work with the hands as a means of education.



More than this, psychologists and theoretical educationists have frequently insisted on the value of the training of the hand in childhood as an aid to the development of the brain centres. An empirical proof of this may be cited in the fact that the testimony of teachers, principals and inspectors is to the effect that wherever Handwork has been introduced into the schools, the literary and intellectual work has not suffered. On the contrary, these officials have stated again and again that the ordinary work of the school has been much benefited by the introduction of "Hand-and-Eye Training." This, notwithstanding the fact that the time taken for it encroached to a considerable extent upon that given to the general subjects.

"Educational Handwork," "Manual Training," "Hand-and-Eye Training," or by whatever name we choose to designate this branch of school work, is based upon true educational principles, in that it seeks to *draw out* the latent powers of the future men and women by enabling them to express themselves in concrete and tangible form. Froebel's dictum, that "the most valuable part of the process of education is that which is spontaneous in the pupil"; or, as later writers have put it, that "the self-activity of the child" should be the impelling motive in school work, is exemplified and applied throughout the course.

Children love to handle, to do and to make things, and a nation's civilization is directly in proportion to its power to *do*, and to bring into subjection the powers and forces of the material world. As a contribution to this end, and to the end which a great educationist has told us is the true aim of education, "the acquisition of power,"

Handwork is to-day accepted as worthy of a place in the school curriculum.

The principle being accepted, there remained the practical problem of the discovery of the best means of putting it into operation, and the most suitable mediums for its practice.

In most countries to-day Manual Training in wood and metal-working is recognized as the most suitable form of educational handwork for the older boys; Domestic or Household Science, Sewing, Dress-cutting, etc., being given to the older girls.

For the younger pupils a great variety of materials and occupations have been tried. Knitting, sewing, clay-modeling, weaving, basket-making, raffia work, wire-bending, paper-folding, colour work in paper, crayon and water-colour, cardboard-cutting, etc., are some that have been found suitable.

To deal adequately with each of these within the limits of a single volume would be impossible. Some of them require special training on the part of the teacher; others involve the use of special appliances and of materials not always available. The courses of work here given have therefore been designed in mediums that are cheap and easily obtainable, that require no expensive apparatus and are capable of being taken up by any teacher possessed of time and inclination for a very little preliminary practice.

Throughout the work, Drawing has been associated with the Handwork — this for several reasons. Drawing is in itself a very valuable form of Manual Training, but often fails of accomplishing its full aim from the fact that much of

the school drawing has been meaningless and devoid of interest for the children. When, however, as in the subject before us, drawing is directly associated with some concrete *doing*, it becomes another means of expression, a language unexcelled in conciseness and precision, clearness and universality.

As to the time to be devoted to handwork, no very definite rules can be laid down. With very young children, some portion of every day should be given to it. For pupils of middle and upper grades, from one to two hours weekly should be allotted, the longer period to include the necessary drawing. In many schools it has been found a good plan to take this work on Friday afternoons, the effect on the attendance being good and the subject being a welcome relief at a time when teachers and pupils are somewhat weary.

As to the disposition of the articles made, it is a good plan to allow the children to take home their successful pieces of work at the end of the lesson. Many of the exercises given may be utilized for schoolroom decoration, and the joint efforts of a class or group of children can be devoted to this, in addition to the more personal examples of their skill which they are usually anxious to take to their homes.

As a help to teachers taking up this work, the course given has been divided into stages which may be regarded as roughly approximate to the grades of the public schools. As, however, the conditions vary in different districts, the following schedule must be regarded as merely suggestive. The capable teacher will have little difficulty in adapting

some or all of the various branches to the varying capacities of the pupils and the conditions of the regular school work of the locality.

#### SCHEDULE OF SCHEME

- 1ST STAGE.** (a) Constructive work—paper-folding, common objects.  
(b) Free cutting—pictures and common objects.  
(c) Colour study—folding and cutting stars.  
(d) Folding frames—cutting pictures to fit.
- 2ND STAGE.** (a) Constructive work—paper-folding, common objects.  
(b) Free cutting—leaves, etc.  
(c) Colour study—cutting and mounting ; easy pattern making ; mounting simple spectrum scale of six standard colours.  
(d) Colour study—cutting and mounting simple patterns in tints and shades of six standard colours.
- 3RD STAGE.** (a) Constructive work—modelling in stout paper.  
(b) Free cutting—fruit, vegetables, etc.  
(c) Colour study—designing, cutting and mounting simple borders.  
(d) Colour study and design—cutting and mounting in three colours.
- 4TH STAGE.** (a) Constructive work—elementary cardboard modelling.  
(b) Colour study and design—designing, cutting and mounting patterns to fill triangles, rhombs, oblongs and other polygons.  
(c) The decoration of the constructive work.
- 5TH STAGE.** (a) Constructive work—cardboard modelling involving binding, glueing, covering, etc.  
(b) Colour work and design—the decoration of the constructive work.

6TH STAGE. The construction in cardboard of the common type forms of solids.

7TH STAGE. The application of cardboard work to the study of Descriptive Geometry.

In addition to the foregoing, a chapter on Raffia work for pupils of various ages has been included, as being a very suitable and artistic form of Handwork.

It should be borne in mind that the aim of Handwork in elementary schools is educational, rather than vocational. It is evident, however, that more and more stress is to be laid on Industrial education in all civilized countries during the coming years. As a preparation for purely vocational training for industries, the kind of work indicated in this volume has a distinct value. For, apart altogether from the claims made for Handwork in schools because of its value in the general development of the child, it is being recognized more widely every day that the acquirement of skill and dexterity in manipulation for its own sake is at least worth while.

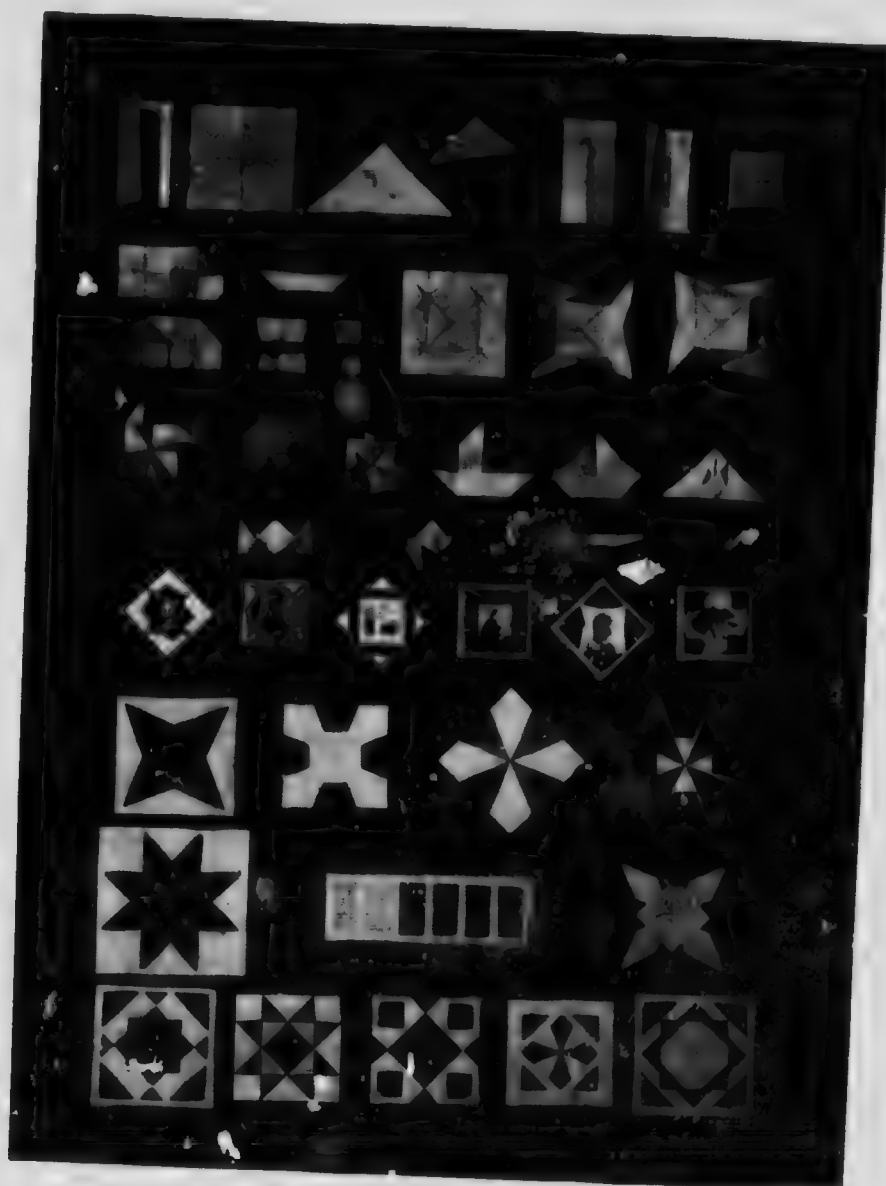
## CHAPTER II

### FIRST STAGE

(a)

THE early exercises in paper folding require a supply of thin coloured paper cut in pieces four inches square; the angles perfectly true and the dimensions exact. It is sometimes possible to obtain such papers from the local printer, but teachers are strongly advised to procure some of the specially prepared papers from any school supply house. Packets of "folding paper" of assorted colours, cut exactly true, can be obtained in four and five inch squares. The smaller size is very suitable for the children's work. Plain white folding paper can also be obtained, but is not nearly so attractive to the little ones.

Good results in paper folding depend largely on patience and care in the early stages of the work, and, from the outset, accuracy rather than speed should be encouraged. Consider the difficulties to be overcome. The child-mind fails to take in the full meaning of what is required, through ignorance, perhaps, of apparently simple terms; and even when the words are understood, the clumsy fingers and untrained eyes fail to carry out the bidding of the little brain. The development of intelligence and ability to express thought should be the teacher's aim, for the main benefit of the work lies in the education of those powers, though the children's desire be merely the power to fold a box or a picture frame.



PAPER FOLDING.

The early stages of the work should be dictated step by step by the teacher, and in giving directions as to the successive steps to be taken, the teacher's words should be few and well chosen. All unnecessary expressions tend to confuse the child and make the dictation vague and unmeaning. A study of each fold should be made so that it may be described in clear, concise terms, and close attention and prompt execution must be required from the children. See that the words *edge, corner, right, left, back, front*, etc., are clearly understood through constant and varied practice at the beginning. Later on, the dictation may be shortened by the introduction of the terms *diameter* and *diagonal*. Let the words *turn* and *fold* each convey distinct meaning, never using *turn* unless the paper is to be turned upside down, or turned round on the desk. In order to explain a difficult step, the teacher should demonstrate with a piece of paper, allowing the backward children to imitate.

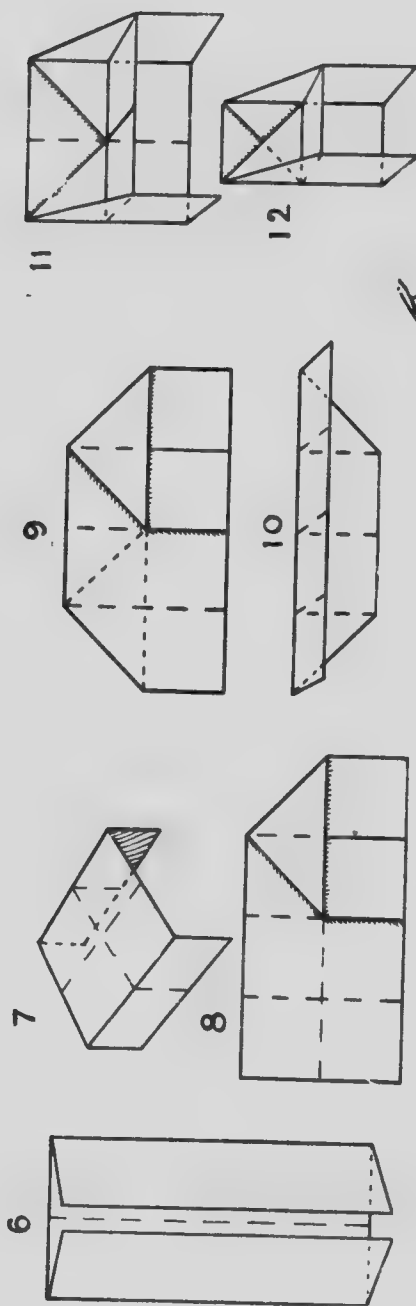
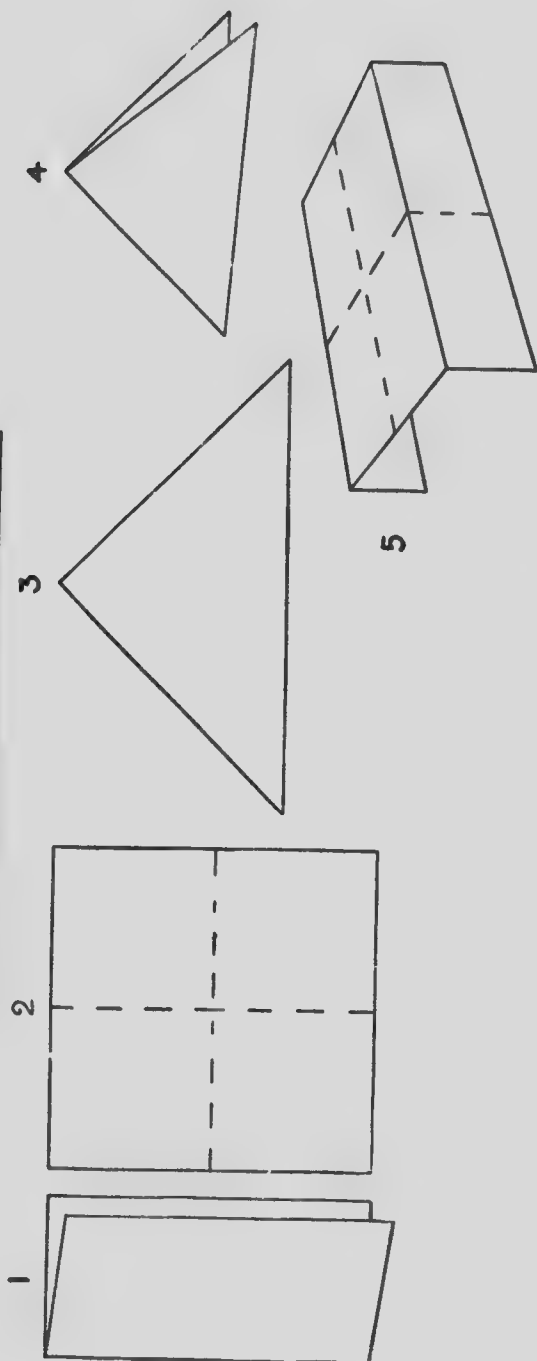
Fold on the desk, not in the air, unless the directions are to lift the paper. When forming the creases, use the tips of the fingers, or, occasionally, the back of the thumb-nail if required.

In general, avoid naming the forms previously to their being folded; the children's imagination will enable them to suggest the name as they notice resemblances to familiar objects.

After the children have become somewhat skilled in the work it is good practice for them to fold from memory occasionally. It is also a good plan to encourage them to describe the method of folding a certain form, the successive steps being dictated to the class by different individuals. The



# First Folding Exercises



8.

children, too, will often suggest new developments of the key form, and all such attempts at originality should be welcomed and carefully fostered.

In the following series, and indeed through the whole volume, the greatest care has been taken with the "progression" of the exercises. From the "known to the unknown," from the simple to the complex, are the maxims throughout.

N.B. The dotted lines in the diagrams indicate creases.

1. **Book or Screen.** Place the square of paper on the desk with an edge to the front. Fold the front edge to the back edge.

Write or draw in the book, or paste pictures in it. If used as a screen, stand it on the desk and describe imaginary things behind it.

2. **Window.** Fold the right edge to the left. Open, and fold the front edge to the back. Open again and observe the direction of the creases.

Decorate the window panes as with frost pictures, curtains or blinds.

3. **Tent.** Fold the front right corner to the back left corner, or place the paper with a corner to the front and fold the front corner to the back.

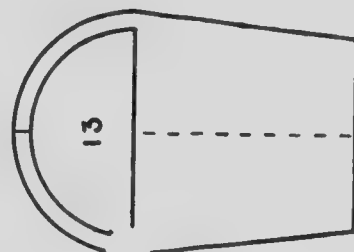
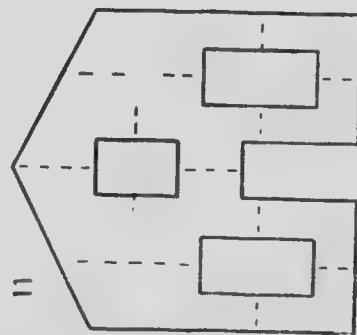
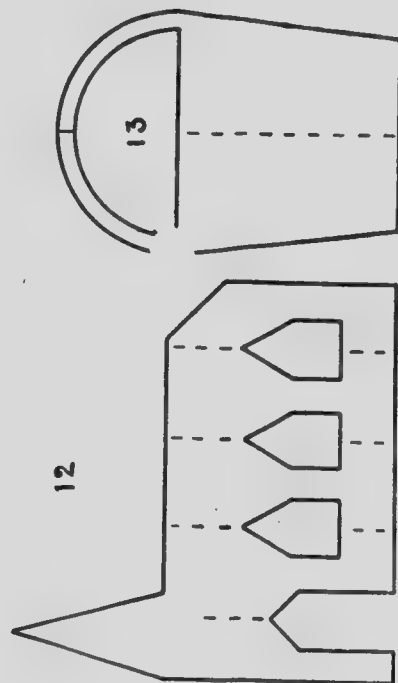
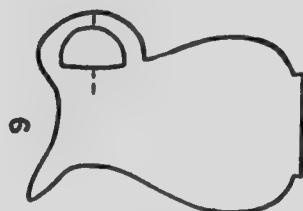
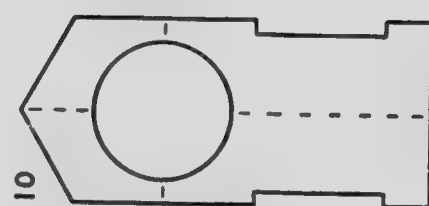
Notice one long edge and two short ones. Describe different uses of a tent.

4. **Snow-plough.** Fold the front corner to the back. Without opening, fold the right corner to the left. Stand on the desk, resting on the long edges.

5. **Table.** Fold the front edge to the back. Open and press the crease flat. Fold the front edge to the crease. Fold the back edge to the crease. Open the last two folds halfway, and turn over.

How long is this table? How wide is it? Where does father sit? Where the mother and others of the family? Encourage free play of imagination and cultivate clear expression of thought.

# Freehand Cutting - Common Objects.



6. **Closet with two doors.** Fold right edge to left. Open, and fold left and right edges to the crease. Stand upright on the desk so that the doors will open and close.

7. **Footstool.** Fold the book. Lay on desk with a short edge in front. Fold the right edge to the left. Open this fold and fold the front edge to the back. Open, and fold the front and back edges to the crease. Open the last two folds half way, and turn over to form footstool.

8. **Barn.** Fold the footstool. Let it lie on the desk with the supports uppermost, having the folded edge at the back. Lay the support at the left down flat on the desk and let the support at the right open. Slip one finger into this opening, folding half the support to the right and half to the left, forming a roof.

9. **A House.** Fold the footstool. Open the support at the right side and fold down as for the barn. Open the support at the left similarly, but, after the roof is formed, fold the right side of this support over to the left.

10. **A Shelf.** Fold the house. Make the right side like the left. Fold the front edge to the back. Open the last fold half way and place against the wall as shown in diagram.

11. **A Garden Seat.** Fold the barn. Make the left side like the right. (Double house.) Notice the short upper front edge. Fold it to the back edge. Fold the right side to the middle. Fold the left side to the middle. Open the last three folds half way to form seat.

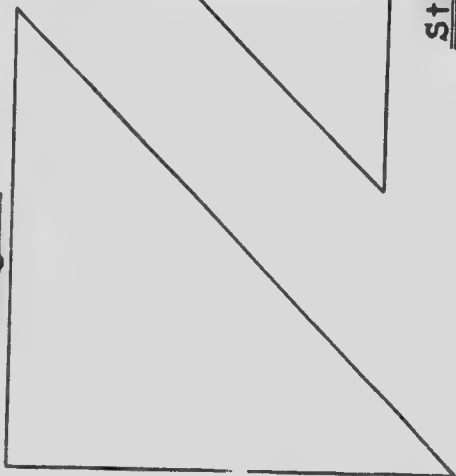
12. **A Chair.** Fold right edge to left. Open, and fold right and left edges to crease. Open, and tear off right-hand quarter. Fold the back edge to the front. Open both left and right sides as in the seat and finish by similar folds.

(b)

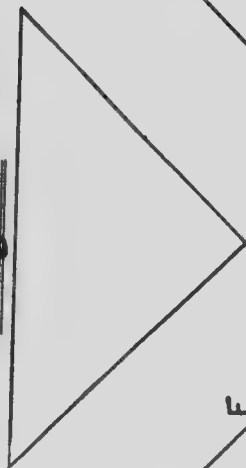
This stage will involve the use of scissors, blunt pointed ones being desirable for young children. Suitable scissors can be obtained from any school supply house, but it should be remembered in buying that a fairly good quality will be found the cheapest in the end.

# Stars - Folds for cutting.

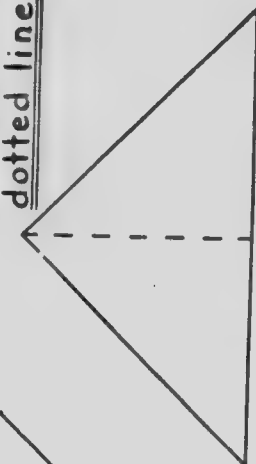
Stage 1



Stage 2



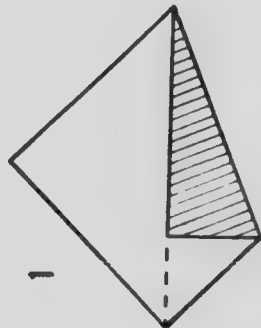
Cut on the  
dotted line.



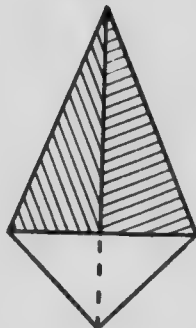
Stage 3

Stage 4

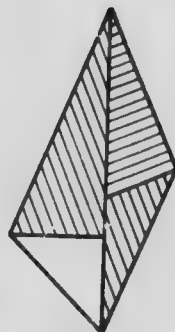
## Folding the Rhombs.



1



2



3



4

For first exercises in cutting, the illustrations in old magazines and advertising pages of periodicals will afford good practice. The manner of holding the scissors should be carefully taught, correct holding being halfway to correct using. The thumb should be placed through the upper loop, and the *second* finger through the lower loop, the index finger being held in *front* of the lower loop. Cutting with the point of the scissors leads to poor work, therefore the children should be instructed to open the blades well.

After some practice in cutting out pictures, a very interesting field may be entered by the introduction of "free-cutting" with the scissors. A few suggestions are given in the diagram, and many more will be given to teachers and pupils. The dotted lines in the illustrations indicate where the exercise has to be folded, either to obtain a symmetrical object, as in the bowl, or to enable an opening to be cut, such as the windows of the house.

Common manilla wrapping paper is very suitable for these exercises, which should be used to illustrate various lessons, being especially useful in language and story telling.

(c)

The next stage, the Stars, will involve cutting to a straight line, through four thicknesses of paper, to obtain four two-inch squares from one four-inch piece, and is a convenient place to introduce the study of colour. For this, "coated" papers will be necessary, the tones of the "engine-coloured" folding papers not being suitable for systematic lessons on colour.

\* "One serious obstacle in the way of colour teaching is the lack of certain universally recognized standards. There are many reds and greens and there is a need for something to lay one's hand on, saying: 'This is red, all the others so-called are but deviations in one form or another from what you see here,' and so with orange, yellow, green, blue and violet. Then, again, the indiscriminate use in common conversation of words denoting colour, such as *tint*, *shade*, *hue*, etc., only adds to the confusion of thought."

To obviate this, the whole of the exercises in colour in this book have been based upon the excellent system of classification and nomenclature devised by Milton Bradley. The six "standard" colours should be dealt with first, and the children thoroughly familiarized with them by using in the folding and cutting of the next six exercises, also by as many examples as can be obtained in ribbon, silk, flannel, Shetland, zephyr and Berlin wool, fruit, flowers, clothing, etc.

In the early lessons it is not advisable to adhere to the order of the spectrum scale of colours. Better results are obtained by commencing with red, and after that colour is well known, blue may then be given, followed by yellow. The children should be quite familiar with these three colours before orange, green or violet are given.

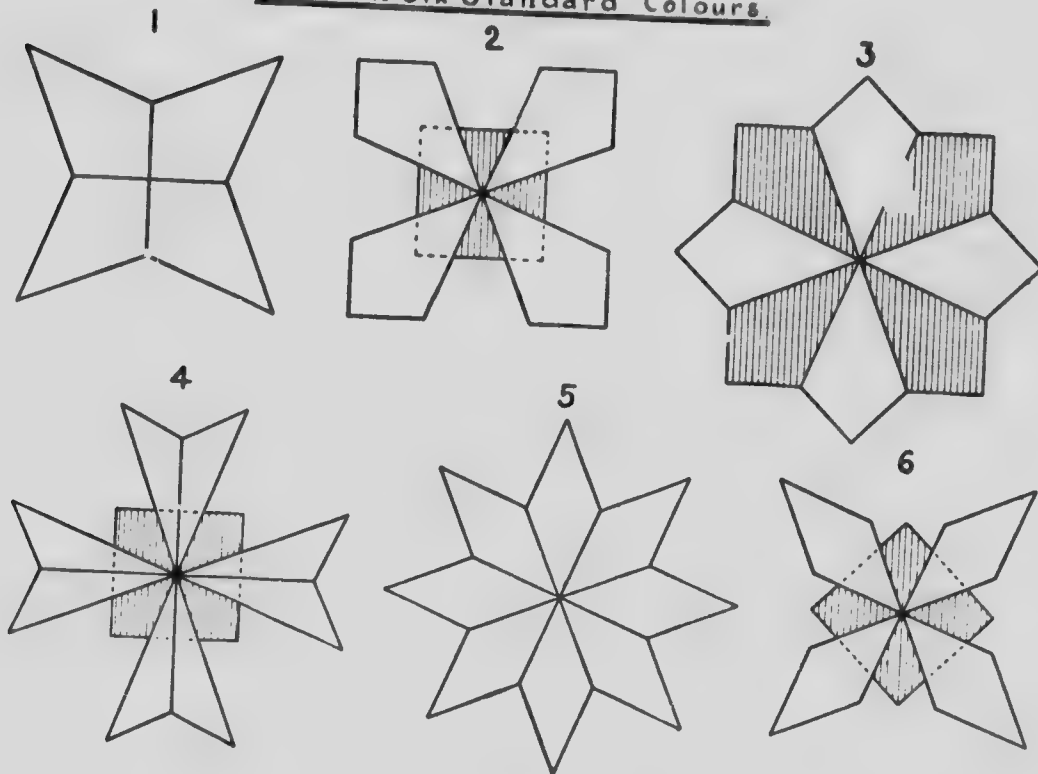
The diagram shows the method of folding and cutting the four-inch square to obtain two-inch pieces. Fold the square on a diagonal and fold again (as in snow-plough). Lay the folded square on the desk as in Stage 3 in diagram, *F* being the last fold. Fold the upper portion from the left corner to the right, crease and open. By cutting on the crease, four two-inch squares are obtained, each having a crease along one

\* *Colour Lessons*, by Mrs. S. B. Patterson.

diagonal. The succeeding steps can be easily understood from the illustrations.

Mucilage or photo paste is the best adhesive medium and should be served out very sparingly and applied with a wooden toothpick or nail, instead of a brush.

Stars in Six Standard Colours.



**STARS.**

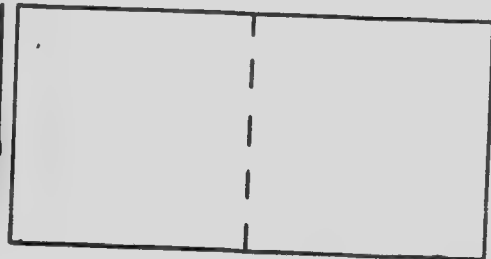
1. **Red.** After the four trapezoids are folded they should be pasted or gummed to a plain two-inch square.

2. **Yellow.** A two-inch square of neutral grey or white forms a good background upon which to stick the units. Care must be taken to place them properly, the background being creased on both diagonals as a guide.

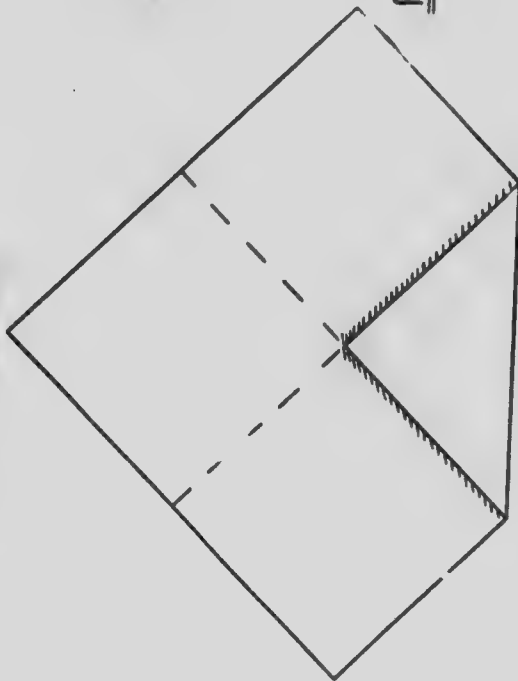


# First Key Form

## Stages 1 & 2

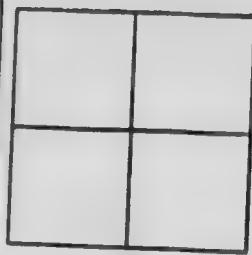


## Stage 3

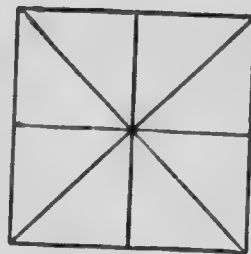


## Final Form

### Back

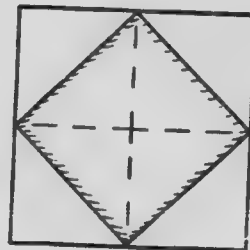


### Front

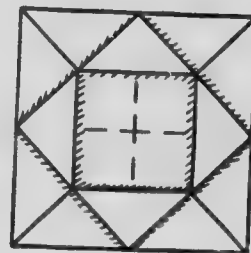


## Picture Frames

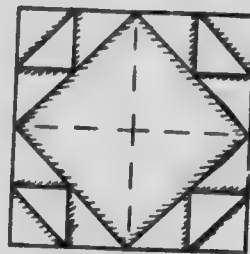
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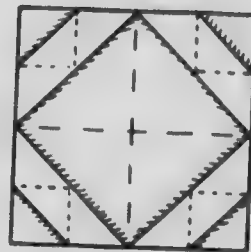
2



3



4



16

3. **Yellow.** A four-inch square is used for the background in this case, the *diameters* of it being creased as a guide.
4. **Orange.** The units of this star (or Maltese cross) are formed by folding a trapezoid double.
5. **Green.** Introduces the rhombus or "diamond," as the children should call it.
6. **Violet.** Explains itself.

(d)

The last portion of Stage 1 is always an interesting one for the children, the folding of the small frames, and the cutting out of heads and faces to fill them, appealing to their social instincts, and to their innate desire to "make" something.

The key form is simple and the stages are shown in the diagram, but for the sake of clearness the following directions, which should be dictated to the children, are set forth in order :—

FIRST KEY FORM. Fold front edge to back. Open. Fold right edge to left. Open. Fold corners to centre. Turn over (without opening). Fold new corners to centre.

The several frames given are obtained from the folded key form. No. 1 is made by folding back the corners of the squares, which show on the *back* of the form. No. 2, by folding back the point of the triangles on the *front* of the form. Nos. 3 and 4 are variants on No. 1, and several others will be suggested by the pupils after a few trials.

The engine-coloured papers make very satisfactory frames and have a great variety of colours amongst them.

"A prism hung in a window (or even a glass pendant from some old lamp or chandelier) where it will catch the sunshine, brightens up a school-room and delights the children by the bands of spectrum colours thrown on floor, walls, desks, etc. Possibly a little moral teaching may be suggested as a child tries and tries in vain to catch these fleeting colours,—we can enjoy many things which we may not grasp, for different reasons, viz., they may not be tangible, or they may be the property of another person, or they may be delicate and easily injured."

S. B. P.

#### OTHER EXERCISES SUITABLE FOR THIS STAGE

"Fold paper and practise tearing evenly through the creases. After tearing off a number of strips make them into lamplighters for home use."

S. B. P.

"Narrow strips of paper may often be obtained from the waste of printers' cutting machines. These strips may be cut, or creased and torn evenly into certain given lengths, four-inch or five-inch pieces, etc. After each piece is torn off, not before, test accuracy by actual measurement. For this purpose the children may have sticks of the given length, or strips of cardboard, or a foot-rule. Good pieces can be kept for making paper chains and cat-stairs."

S. B. P.

"PAPER CAPS. Use an oblong sheet of paper, any size, from a small piece 3 by 4 inches to half a sheet of newspaper which makes a cap large enough for a child's head. Lay the oblong sheet of paper on the desk with the long edges at the right and left. Fold the front edge to the back. Without opening, fold the right edge to the left. Now open the last fold and observe the crease made. Fold half of the front edge to this crease. Fold the remainder of the front edge to the same crease. Open the paper at the back edge and fold the upper portion towards the front as far as it will go. Fold remaining portion similarly on opposite side of cap. If the edges that extend past the triangular form are now folded over and gummed, the cap will be stronger and of better shape."

S. B. P.

## CHAPTER III

### SECOND STAGE

(c)

THE constructive work in this stage consists of paper folding from a somewhat more difficult key form than in Stage 1.

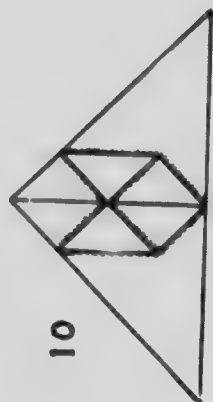
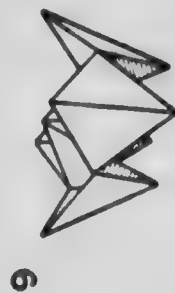
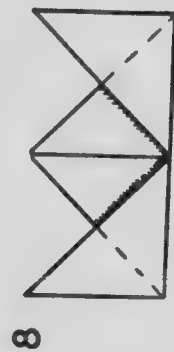
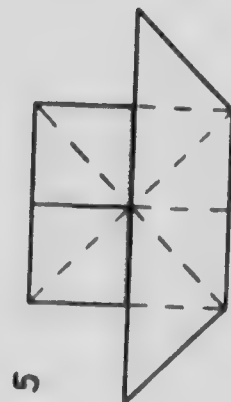
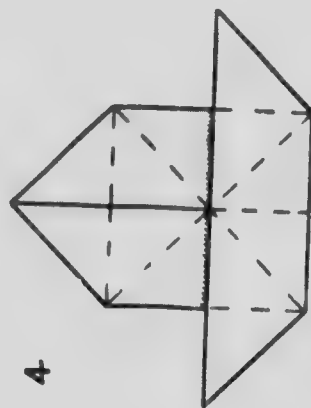
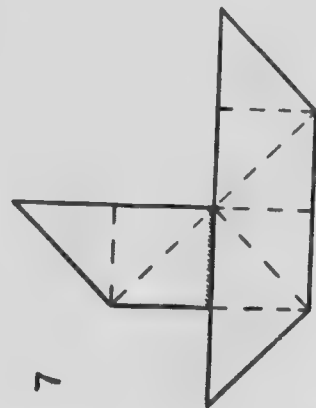
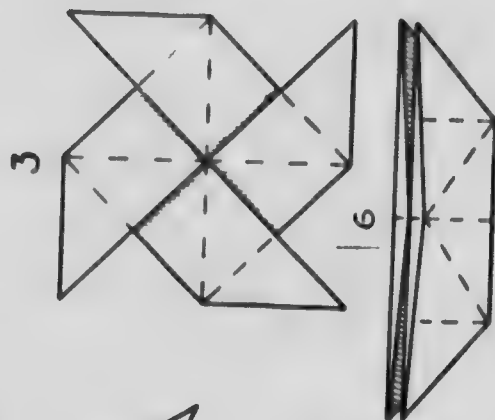
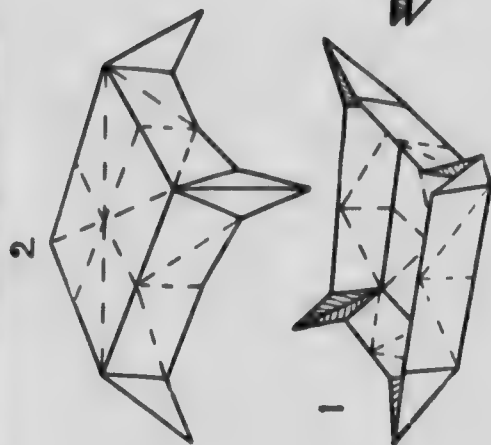
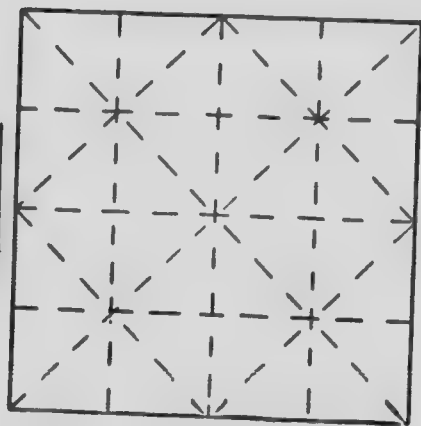
The diagram shows the appearance of the key form after all the creases have been made, the following being the order of work for folding : -

Place paper with an edge near you. Fold front edge to back edge. Open, and fold right edge to left edge. Open, and place cornerwise. Fold front corner to back corner. Open, and fold right corner to left corner. Open. (These folds mark the diameters and diagonals.) *Turn paper over.* Fold corners to centre strictly in following order : front, back, right and left. *Turn paper over.* Fold corners to centre in same order as before. Turn back these folds and pull out corners from underneath, till paper is flat. This last order must be strictly followed or the paper may get reversed and creases will not fold correctly in making the exercises built upon this form. Observe the two-inch square in centre, having its edges parallel to the edges of the paper.

1. **A Cake or Candy Basket.** Fold key form. Turn up edges round centre square. Pinch or paste corners together.
2. **A Table-cloth.** Fold the basket (but do not paste corners). Turn over.

# Second Key Form

Opened



3. **A Windmill or Pin Wheel.** Fold the basket; press its sides down; on centre square, leaving corners standing. Turn corners down one after the other in the same direction.

4. **A House-boat or Noah's Ark.** Fold for windmill; turn down two corners to meet at back to form the house. Turn down remaining corners to right and left to form boat.

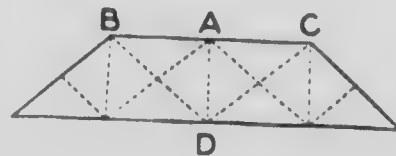
5. **A Cup and Saucer.** Fold the Noah's Ark. Turn down points of roof.

6. **A Double Boat.** Fold for the windmill, but turn down points to meet in pairs. Fold on *diameter* of under square.

7. **A Sail Boat.** Fold for the windmill. Fold on *diagonal* of the under square. Notice points standing out at front and back, and fold them together.

8. **A Crown.** Fold key form. Turn over and fold front and back corners to centre. Fold front edge to back edge, giving this form.

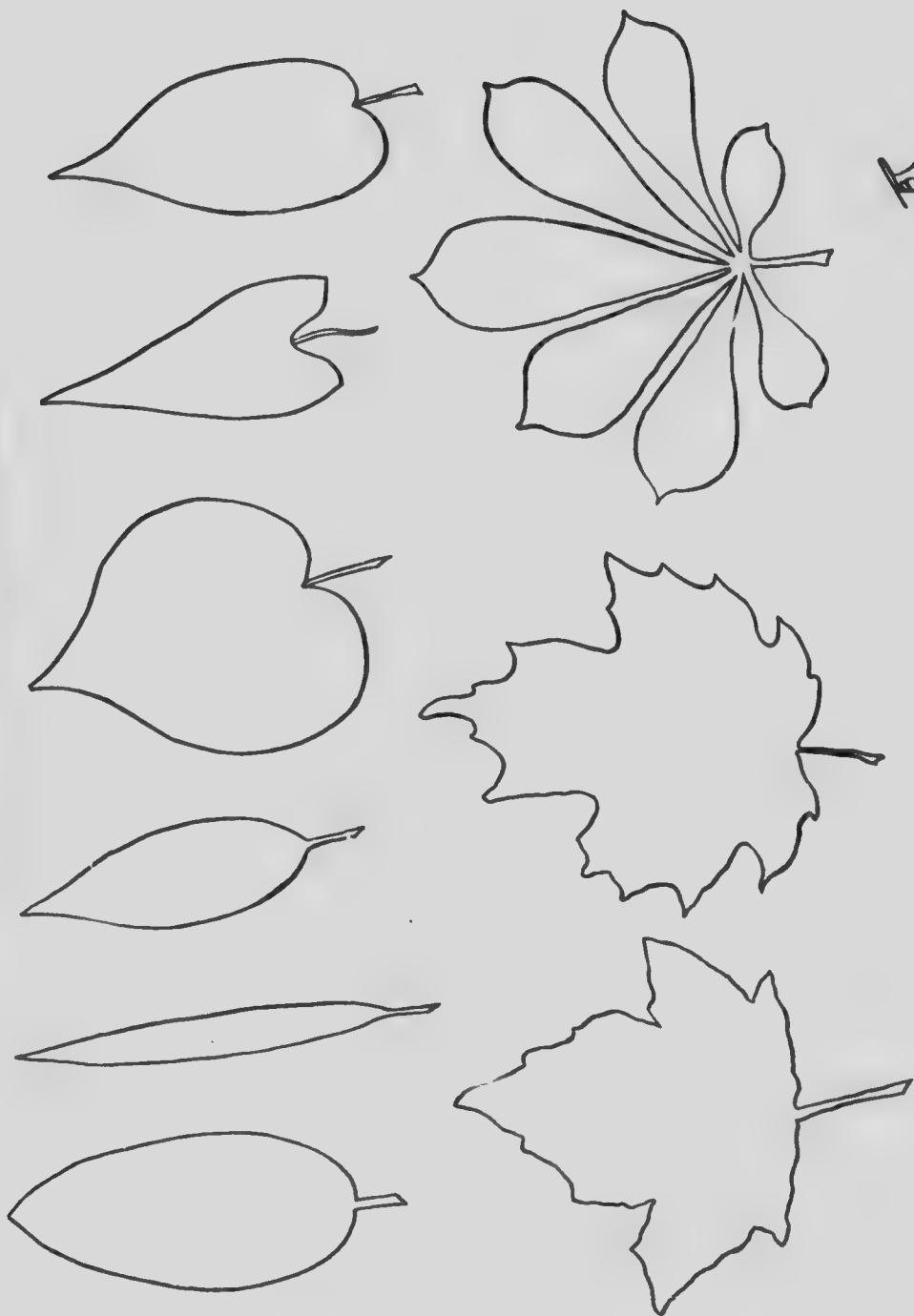
Hold the form at A with thumb and finger of left hand. Notice front and back corners at B and C. Fold front corners forward and back corners backward to meet at D.



9. **A Work-basket.** Fold for key form, but do not open. Turn over the folded form so that the four squares are uppermost. Press the four corners of the folded form underneath until they meet, thus raising centre of form. Pull out the single squares to form pockets. Stand basket on points.

10. **An Admiral's Hat.** *Not from key form.* Place paper with corner near you. Fold front corner to back. Open, and fold right corner to left. Open, and turn paper over. Place with edge near you. Fold front edge to back edge. Open, and with the first finger of each hand press the ends of diameter underneath until they meet; this gives two large triangles in front and rear, which must be pressed flat together. Lay on desk with long edge near you. Fold right *upper* corner to back corner. Fold left *upper* corner to back; this gives a small square. Fold right and left corners of square to meet on centre line. (Note that "upper" does not mean "back.")

Freehand Cutting - Leaves



12

(b)

The exercises for free cutting in this stage may be made a useful adjunct to the Nature work of the school. The leaf forms suggested in the diagram may be traced from actual specimens at first and afterwards be cut from memory. Leaves with simple curves should be chosen for the earlier attempts, compound curves and irregular edges being taken later.

The leaves in the diagram are "conventionalized"; *i.e.*, simplified by modifying the serrations, etc., of the outlines.

Various uses may be made of the leaves, notably in the decoration of the schoolroom, and of picture frames, etc.

(c)

The cutting and mounting exercises of Stage 2 will again bring in the study of colour, and also afford opportunity for the display of some originality in cutting and arranging very simple elements in easy patterns.

The materials required are some coated papers in the six standard colours, some pieces of thin white cardboard cut to four inches square, upon which to mount the patterns, and some good mucilage. Tiny saucers and camel-hair brushes are also necessary. If brush-work is taken up in the school, the same brushes and paint saucers may be utilized for that work.

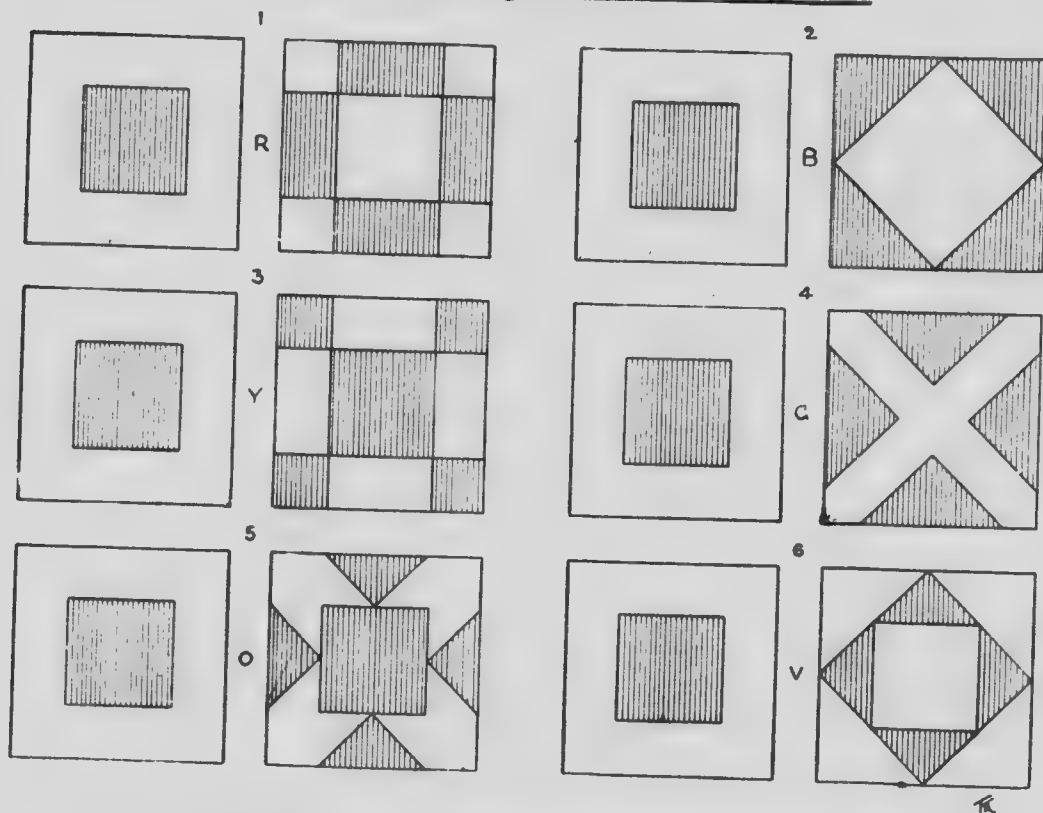
The order of introduction of the several colours should be that suggested in Stage 1. Some suggestions for simple pattern making are given in the diagram, and many modifications and variations may be found as the work proceeds.



Commence with each colour by carefully folding a four-inch square of coated paper on its diameters. Open and cut along the creased lines, thus obtaining four 2-inch squares.

(N.B. Coated papers with lines ruled on the back may be obtained at a slight additional cost, and are to be preferred, it being easier to cut to a line than to a crease.)

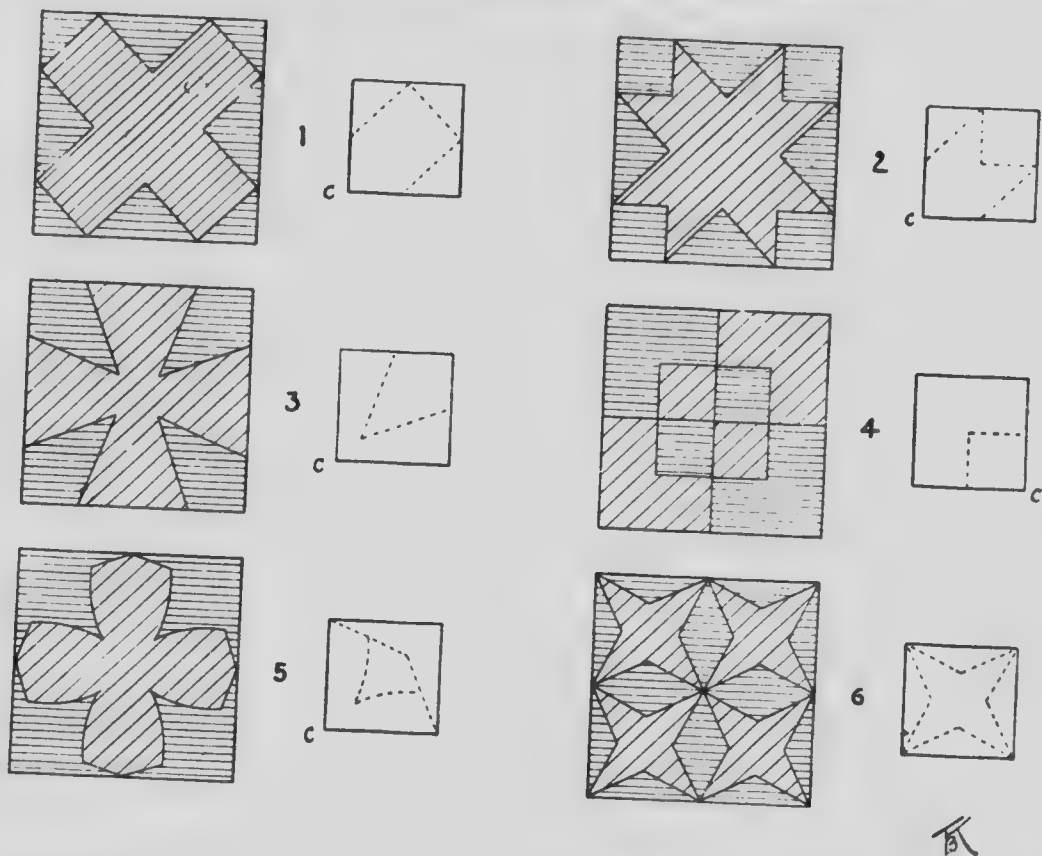
### Pattern Making — Standard Colours



The two-inch squares being obtained, one of them should be mounted in the centre of the four-inch card (see diagram). A very small quantity of mucilage should be served out on the small saucers, just a drop or two being sufficient, or the children may put an excess on their papers and spoil the

work. A clean slate or piece of waste paper is useful for laying the pieces of coated paper on while applying the mucilage, which must be brushed evenly over the paper, but

Pattern Making - Tints & Shades.



should not be laid on quite to the edges. If a tiny margin of plain paper be left, there is less danger of getting the mucilage on the face of the paper, and enough will be squeezed out to the edges in mounting to ensure their being stuck down properly. After the mucilage is applied, the piece of paper

should be lifted by the brush and turned over into position on the card mount. As soon as possible after being placed in the right position the paper should be pressed down firmly, using the side of the hand and laying a piece of newspaper over the piece of coloured paper to prevent it being soiled.

SIMPLE SPECTRUM SCALE

Standard Colours

R	O	Y	G	B	V
---	---	---	---	---	---

SCALE WITH TINTS AND SHADES

R	O	Y	G	B	V
TINT	T	T	T	T	T
STANDARD	SI	SI	SI	SI	SI
SHADE	S	S	S	S	S

This will probably be quite enough for one lesson, and the pieces of paper left over should be put away carefully for the next. For storing such pieces, also unfinished exercises, each pupil should be supplied with an envelope. Suitable envelopes may be easily constructed by the older pupils out of wrapping paper, as suggested for Ex. 18, in Chap. 5, and should be about 8 by 10 inches.

The brushes and saucers should be cleansed by being washed in cold water before the mucilage hardens in them, and dried ready for the next lesson. This consists in cutting two of the remaining squares into triangles, oblongs, smaller squares, etc., and arranging them into patterns to be mounted on the back of the card upon which the two-inch square has been gummed. This will afford some scope for the inventive genius of the pupils, who will suggest many patterns besides those in the diagram.

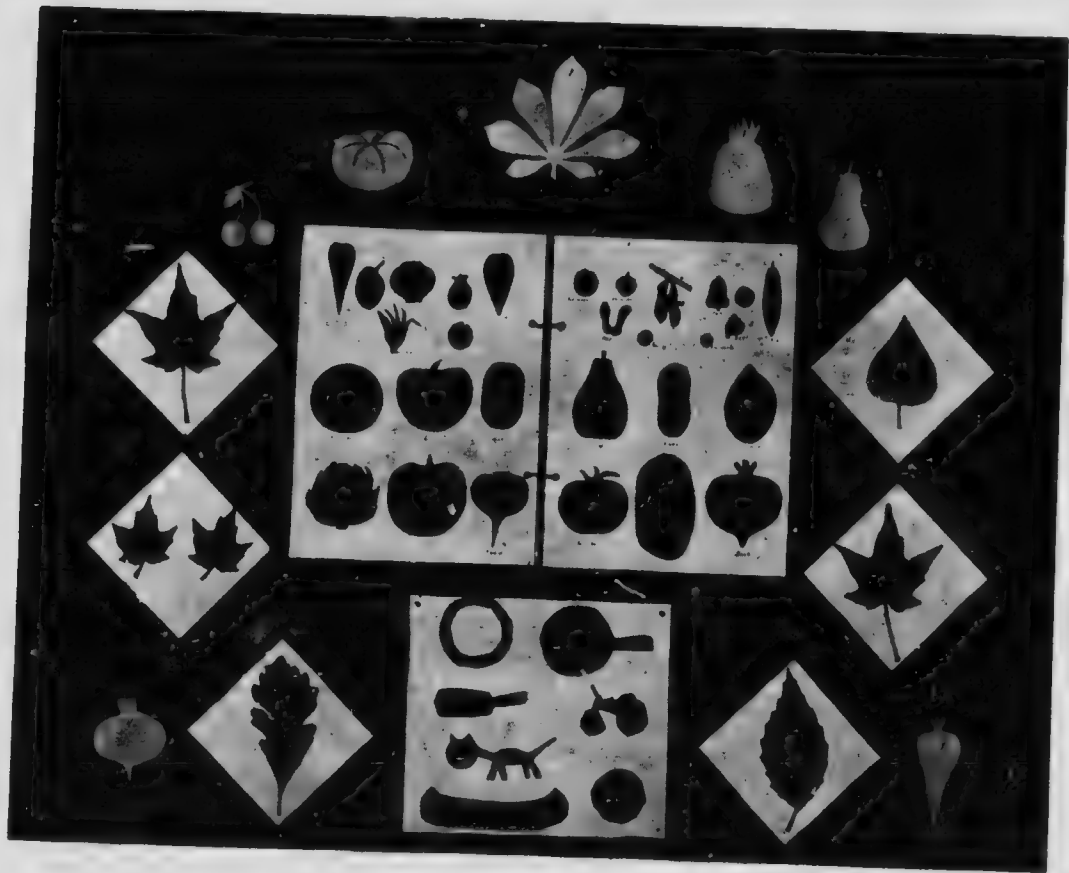
The fourth two-inch square should be kept until the six colours have been worked through, and then used to form a simple spectrum scale of six colours, arranged in their proper order (see diagram), and mounted on strips of card by each pupil.

In this and the succeeding stages of cutting and mounting, the patterns should be used for drawing lessons, both for large "free-arm" work on the blackboards and for book or slate work. Training in the fundamental principles of horizontal, vertical and oblique lines; of squares and their division; of simple curves and of elementary design, may thus be given in a way that impresses them on the minds of the pupils.

(d)

The second stage of cutting and mounting introduces the idea of colour groups or families. As every colour begins in light and ends in darkness, the scale of any colour will range from white to black, the standard colour coming in the centre of the scale. The tones between the colour itself and the white end of its scale are known as *tints*; those

between the colour and the black end as *shades*. In other words, a tint may be obtained by adding white to a standard colour; a shade, by the addition of black. The pupils may



FREE CUTTING EXERCISES.

test this by holding, say, a standard red paper in direct sunlight, in diffused light and in deep shadow; or, if water-colours are available, the tints and shades may be formed by the addition of a little white or black to a standard colour.

For the present it is suggested that the pupils should be familiarized with one tint and one shade of the six colours already studied. In the diagram on page 35 suggestions for some simple patterns are given. The small squares at the side of the patterns show the method of folding and the lines for cutting, the corner marked *C* being the centre of the folded sheet.

The designs may be mounted on cards or in drawing books, the latter being quite suitable. Commence by mounting a four-inch square of the darkest shade of standard red, then cut a pattern from the lightest tint of the same colour and mount it upon the shade. In this, great care and neatness in the manipulation are necessary. The mucilage must be applied evenly and quickly to the back of the pieces to be mounted, especial care being taken to avoid soiling the finished design with mucilage from the edges of the pattern or from sticky fingers.

Of course the order just suggested may be reversed and the tint mounted first, leaving the pattern to be cut out of the shade. It is a good plan to require some pupils to do it one way, and some the other, and to allow them to choose their own way after an inspection of the teacher's samples.

It need scarcely be remarked that no exercise should be attempted unless the teacher has previously worked it out and noted the points of difficulty, etc.

## CHAPTER IV

### THIRD STAGE

(i)

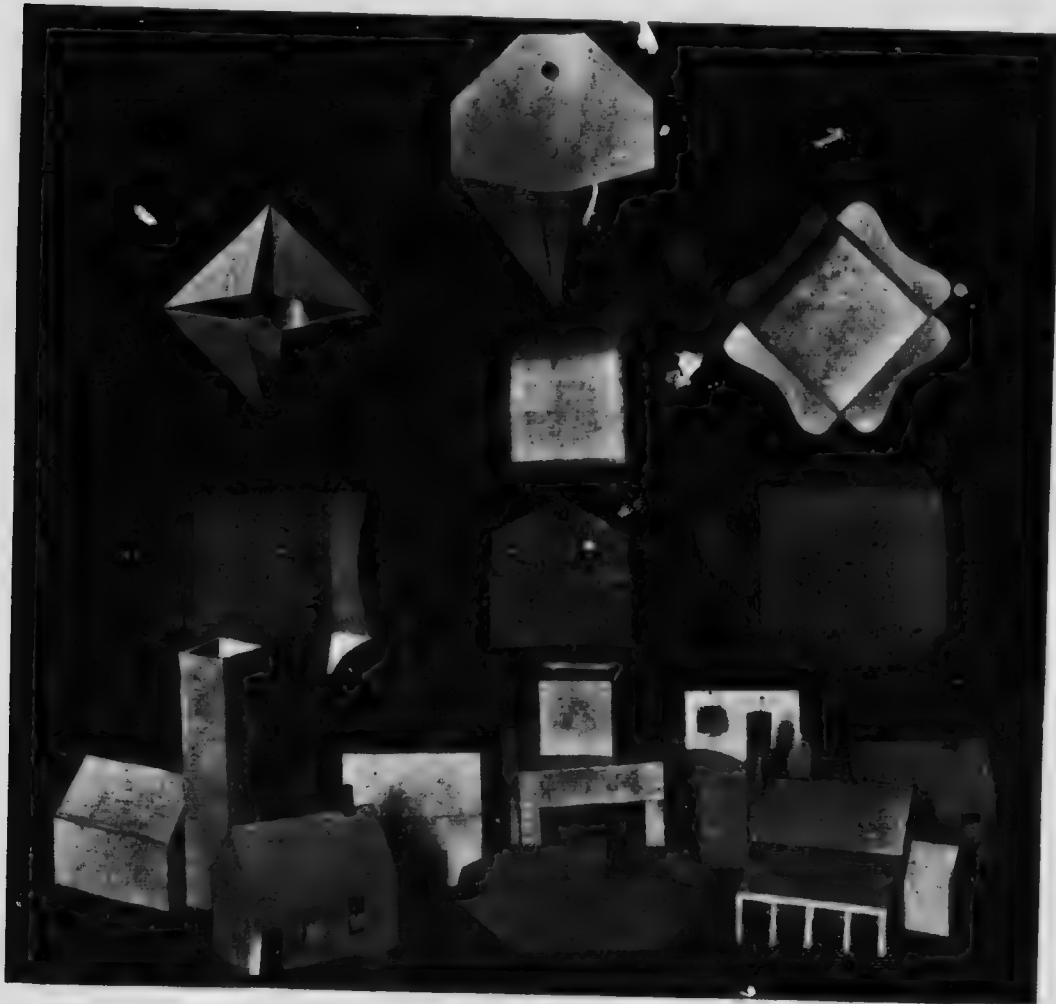
THE constructive work in this stage involves the use of the ruler in measuring and drawing the various figures. No other drawing instrument is required, the exercises being based upon the square and the angles being obtained from the edges of the paper.

The material used is stout paper, known to the trade as "Manilla tag," which may be obtained in several colours. "Cover" paper is another very effective material, though rather more expensive, many beautiful colours and patterns being obtainable.

The paper chosen should be cut accurately to eight inches square. The diagrams show the squares with the construction lines necessary for each model; the faint lines being merely helps to construction; the heavy lines indicating that the paper is to be cut quite through where they are shown; the dotted lines, that the paper is to be bent or creased where they occur. The small stars indicate the surfaces to be pasted or glued when putting the model together (paste flaps, hereinafter).

In teaching these exercises, two models of each are necessary; one finished, the other cut out ready to go together, so that it may be folded into shape in view of the pupils. A large square should be drawn on the blackboard,

and each line necessary for the exercise should be suggested by the pupils after an inspection and analysis of the teacher's



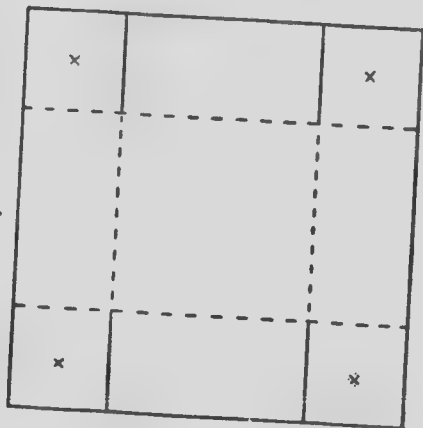
MODELLING IN STOUT PAPER.

two specimens. As each line is decided on, the teacher should draw it on the blackboard, and the pupils on their squares of paper. Later this may be varied by dictating

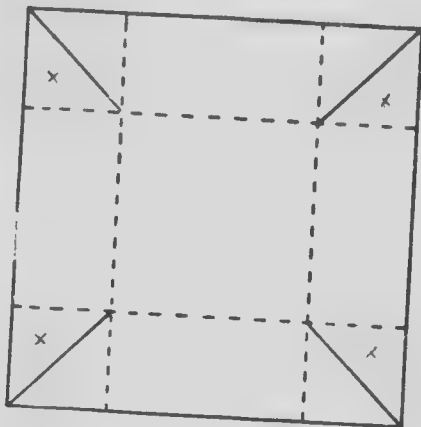


# Constructive Work in Paper. №1.

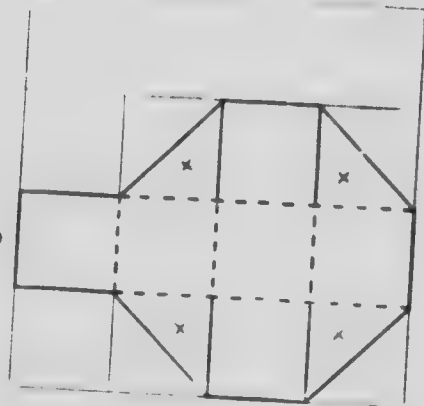
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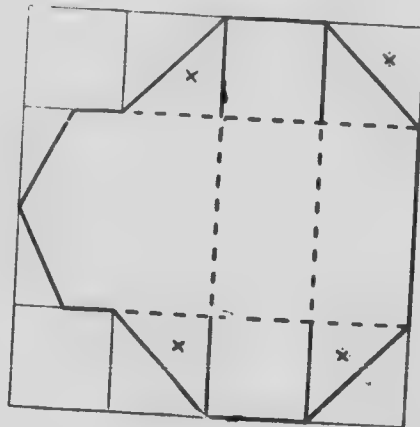
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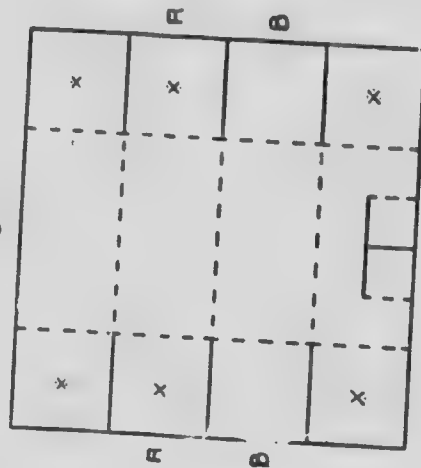
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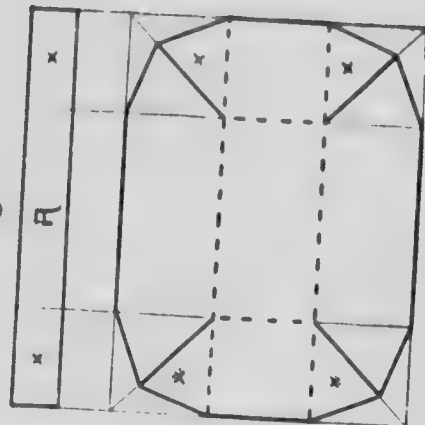
4



5



6



7

the drawing of every line and only displaying the teacher's drawing after the children have finished theirs.

### EXERCISE 1. A BOX-BOX BOX

Commence by drawing a line two inches from each edge of the paper. This will necessitate an explanation of the ruler, and also afford an excellent opportunity for some concrete work in arithmetic.

How large is the central square? How large are the oblongs the small squares in the corners, etc.? The four lines being drawn, one side of each of the corner squares should be cut. Next, the paper should be carefully bent on the remaining lines. If a fairly hard pencil, with a sharp point, be used, the paper will bend neatly at the lines; or, if preferred, the paper may be scored slightly with the point of the scissors. Whichever plan is adopted, the paper must be bent *away from the lines*.

In sticking the corners, the best plan is to slightly moisten one side of the paste flaps with a damp sponge or rag, and paste or glue the other. Not more than one corner should be attempted at once, each one being held in the fingers until set.

Ordinary flour paste will serve for these exercises, although, if the class is a small one, the prepared paste sold in tubes by the stationers is quite suitable.

To prepare the paste, take some plain flour and stir it into cold water until a smooth batter is obtained. Into this pour some boiling water, stirring briskly meanwhile until the mixture thickens. Set aside in a cool place and use

when cold. Such paste is best if made fresh when required, but it will keep for a long time if six or eight drops of a saturated solution of bichloride of mercury (corrosive sublimate, a deadly poison) are added to each pint of paste.

A small quantity of paste should be served out on a scrap of waste card or paper to every two pupils. For applying the paste, a slip of stiff cardboard is better than a brush. A thin film of paste can be scraped on with the cardboard, and if the edge of the latter becomes soft with the paste, it can easily be cut off and a new stiff edge obtained. If paste is not at hand, liquid glue makes an excellent substitute, and is preferred by some teachers.

#### EXERCISE 2. A FRUIT TRAY

Proceed as in Exercise 1, but note that the *diagonals* of the small corner squares are cut. This gives sloping sides to the tray and also necessitates cutting off the corners of the paste flaps after the model has been pasted up into shape.

#### EXERCISE 3. A CUBICAL BOX, WITH COVER

In this exercise a two-inch strip is cut off the eight-inch square. The rest of the drawing and construction is obvious, the box having faces of two inches square.

#### EXERCISE 4. A MATCH-HOLDER

This is similar in construction to Exercise 3, but is oblong instead of cubical, and therefore uses up the whole

of the eight-inch sheet. Note that in obtaining the sloping back, the single inch is used for the first time. Note also that the back is not creased to form a cover, as in Exercise 3, but stands up straight when the model is finished.

#### EXERCISE 5. A BARN

Draw the three horizontal lines, two inches apart, and the two vertical lines, two inches in from the edges. The doors are each one inch high and one inch broad. The surfaces marked *A* are to be pasted to those marked *B*. After these are set, the outer corners can be folded into position, so as to ascertain how much of them need be pasted. Note where they overlap one another; paste and finish.

#### EXERCISE 6. A BASKET

Commence the drawing as in Exercise 5; then draw and cut the strip *A*, one inch wide, for the handle, and cut off and waste the remaining one-inch strip, leaving a piece six by eight inches. Draw the diagonals of the corner squares and measure off two inches on each of them to obtain the shape of the triangular paste flaps. Finish the body of the basket first and affix the handle afterwards.

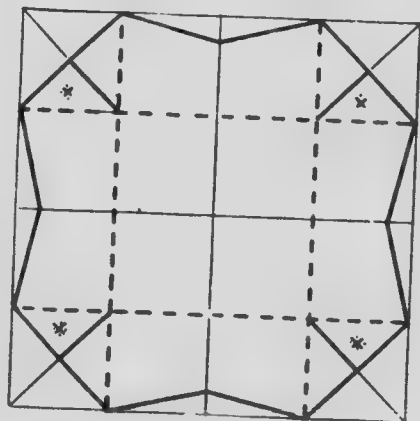
#### EXERCISE 7. A FANCY FRUIT DISH

(This is a repetition, in a more difficult form, of Exercise 2.)

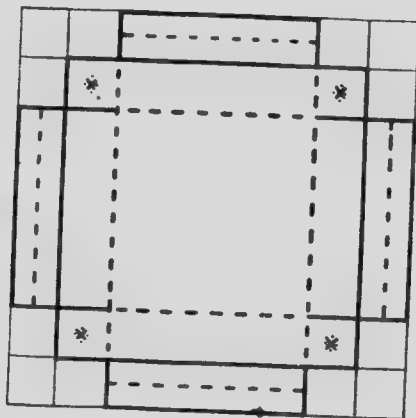
Divide the eight-inch paper into sixteen two-inch squares and draw both diagonals of the corner squares. Measure

# Constructive Work in Paper. No 2.

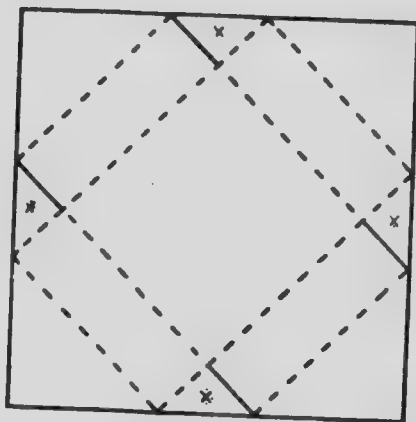
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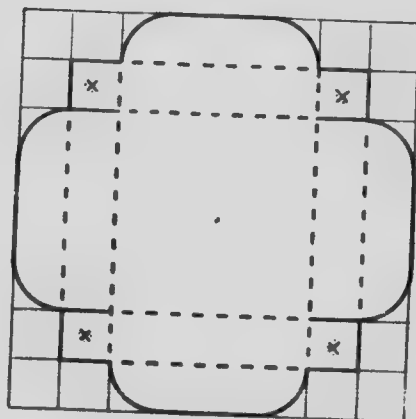
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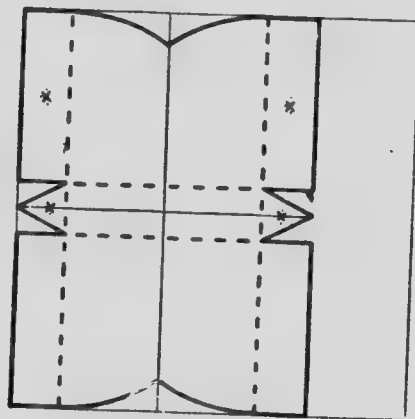
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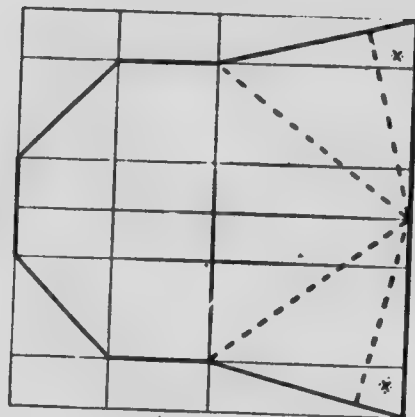
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11



12



13

in half an inch on each end of the central lines to obtain the depth of scallop on the edges. Cut out as shown by the thick lines in diagram, and paste together by the small triangular corners. Note that the half-inch is used for the first time.

#### EXERCISE 8. A SMALL TABLE

Draw lines parallel to, and one inch from, each edge of the square. One inch inside these draw others. Then cut off the outer one-inch strips, leaving a six-inch square with one-inch margin drawn upon it. Cut and crease as directed by the diagram and paste together to form the top and side pieces of the table.

The legs are formed from the one-inch pieces, which were cut off first, and are bent to a right angle down the centre, and pasted into the angles of the sides under the top. Note how the creasing of the legs stiffens them like angle iron in engineering.

#### EXERCISE 9. A CANDY BOX

This exercise involves very careful measuring and drawing, as the construction lines are not parallel to the edges of the eight-inch square. Commence by measuring along each edge three inches from each corner, and join the points thus obtained in the manner shown in the diagram. Cut and bend as directed by the lines, and note that the large triangles form the cover when the box is finished. Tie with ribbon or fancy cord.

N.B. The size may be varied by changing the distance from the corners, as given above.

## EXERCISE 10. A TRINKET TRAY

(This model is a repetition, in a more difficult form, of Exercise 1.)

Commence by drawing lines at one and two inches from each edge of the large square. Cut and crease as directed, the quarter circles upon the marginal pieces being obtained by freehand, or by marking from a circular pattern piece of two inches diameter. After pasting, the marginal pieces stand out level on each side. These pieces may be cut to a variety of patterns, the one given being exceedingly simple.

## EXERCISE 11. A POST-CARD CASE

Commence by measuring and cutting off a two-inch strip, leaving a piece six by eight inches. Draw the centre lines, then marginal lines one inch in from the long edges. Next measure off half an inch on each side of the short centre line to form the bottom of the case. The curves at the ends may be cut to several patterns, that shown being quite easy. The small paste flaps are made triangular to prevent any possibility of an irregular edge interfering with the corner of the model in pasting together.

## EXERCISE 12. A WALL POCKET

This exercise needs care in the drawing, the lines being more difficult to locate.

Draw the centre lines, then a line one inch from the right and left edges; then one on either side of the vertical centre line, and one inch from it. Draw the outline as shown

by the thick line in diagram, and cut out. Measure up one inch on the slanting sides to obtain width of paste flap, bend on the dotted lines and paste together.

The foregoing models may be modified by being made simpler for backward pupils, or more elaborate for the more skilful among them. In all cases, however, accuracy should be insisted on. Let there be no such thing as "near enough," but see that the sizes decided on by the teacher are strictly adhered to, and that the edges, angles, etc., are true.

Habits of exactitude and truth cannot be fostered by this work if the teacher's standard be low. Encourage every effort, however, and if, in the teacher's judgment, some poor attempt should be accepted, its faults must be pointed out and the value duly discounted.

It has been found a good plan to have a system of marking the pieces of practical work when finished, ten marks being allotted for a really first-class piece, others being assessed in proportion. It is also an incentive to healthy rivalry if the best pieces are hung for a few days in some prominent place in the school.

(b)

The objects for free-cutting exercises in this stage are fruits and vegetables, the various outlines of which require careful study to be represented by a mere silhouette of paper. The diagram gives a few suggestions, and the leaves in the previous stage may be repeated as sprays if more exercises are required. The half-tone illustration shows a very useful





FREE CUTTING EXERCISES.

combination of colour-work and free-cutting, wherein the fruits and vegetables are coloured with crayons after cutting out. A well-known nursery rhyme is also shown and is typical of a wide field of interesting work in free-cutting. The seven little pictures made by a class of primary pupils to illustrate or express their conceptions of the days of the week, are also suggestive.

(c)

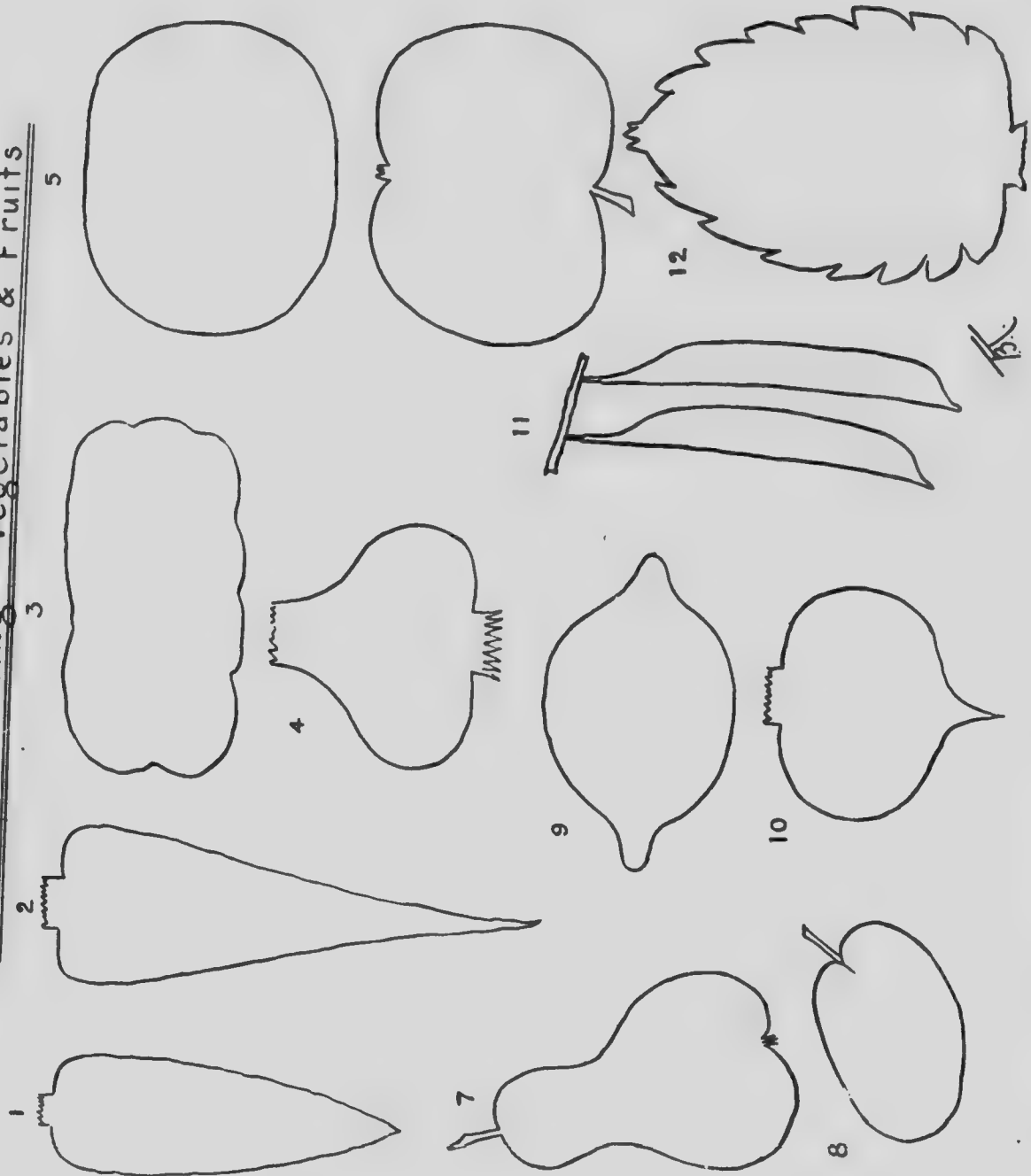
The pattern work in coloured papers for this stage involves the designing, cutting and mounting of some simple borders. A few of these are shown in the diagram, the backgrounds being neutral greys, and the pattern or ornament tints and shades of standard colours.

All the designs given are "repeat" patterns and therefore may be used as borders for frames, etc., of varying sizes. For practice purposes a four-inch square of grey paper may be cut in half and mounted end to end to form a strip eight by two inches upon which to mount the units which form the patterns.

The units should be carefully drawn and, in the case of the straight-lined ones, cut out singly. For the curved units a pattern piece should be cut from a piece of cartridge or manilla paper. The coloured sheet should then be folded several times to a convenient size and the several thicknesses cut to the pattern piece at one operation.

No. 1 border has a background of neutral grey, the triangles composing the pattern being alternately a tint and a shade of a standard colour.

# Freehand Cutting - Vegetables & Fruits



After the grey backgrounds have been mounted, a half sheet (cut by some of the pupils) of coloured paper should be served to every pupil, No. 1 being given a tint, No. 2 a shade, and so on. These pieces must be carefully cut in halves by the pupils and an exchange of one portion effected with the adjacent pupil.

No dimensions are shown in the diagram, but the borders shown are in pieces eight by two inches, and the sizes of the pattern units can be easily obtained.

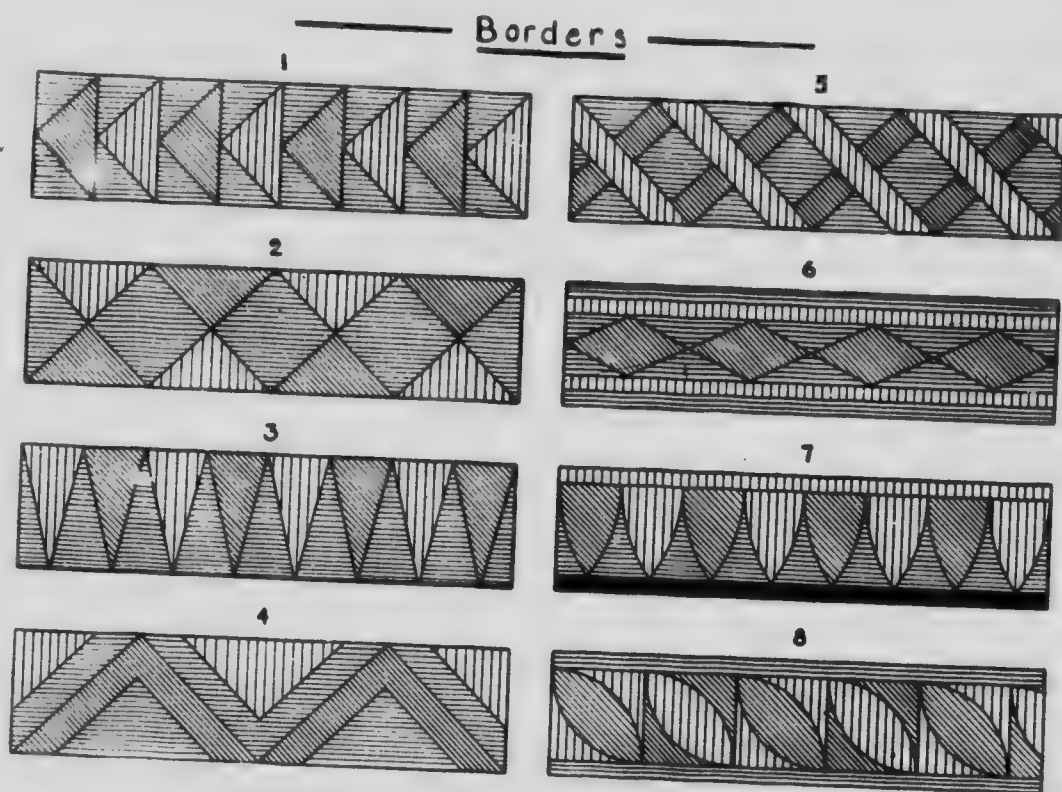
No. 2 is formed from the same unit as No. 1, but is arranged differently, the central squares being formed by the grey of the background. The alternation of tones and the distribution of the papers among the pupils are as in No. 1.

No. 3. The isosceles triangles of this design have an altitude of two inches and a base of one inch. Alternate and distribute as before.

No. 4. The units of this pattern are cut as follows: Fold a four-inch sheet on one diagonal, and then fold the resulting triangle in half. Draw lines half an inch from the *folded edges* of this figure and cut out the small right-angled triangles. Open the remaining strips and cut carefully upon the creases. Half of the pieces thus obtained must then be exchanged with the neighbouring pupil, the four-inch sheets having been distributed alternately in tint and shade.

No. 5. The pattern represents a folded ribbon and is very effective if neatly executed. After mounting the background, divide it into four two-inch squares and draw the diagonals of each. Then cut half a sheet of coloured paper

into four half-inch strips and mount them upon the background, using the diagonals as guides. When these strips are dry, take four similar pieces from an alternative tint or shade, and mount as indicated in the diagram.



No. 6. The rhombs in this design are two by one inches and should be cut from a standard tint. The strips next the rhombs are cut from a corresponding standard shade, mounted so as to leave a margin of grey background showing.

No. 7. The shield forming the unit of ornament in this

design is one inch broad and  $1\frac{1}{2}$  inches high. As suggested above, a pattern piece should be cut from plain paper, and the coloured pieces cut by it.

The marginal strips are a shade of a standard colour; the shields a tint of the same.

No. 8. This design may be carried out in several ways, a very good effect being obtained by counterchanging a tint and shade to form the ornament and the background. The margins may then be of neutral grey.

Other combinations of simple units may be easily discovered, the foregoing patterns being merely suggestive.

(d)

The last portion of Stage 3 is illustrated on page 56, where some suggestions for pattern work in three colours are given.

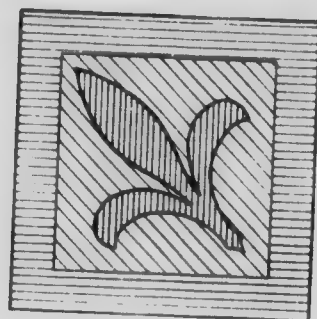
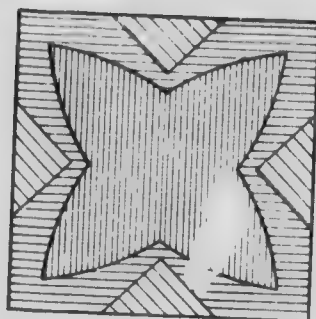
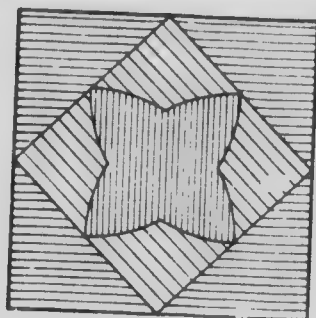
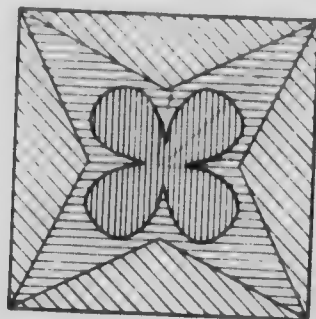
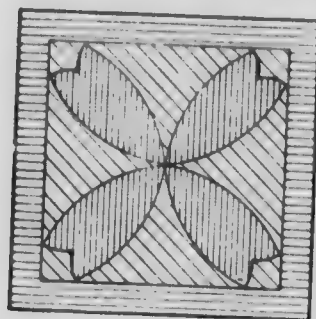
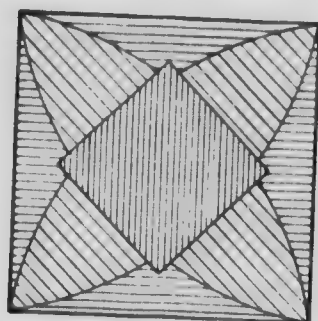
Following out the previous suggestions for colour study, these patterns may consist of a standard colour and a tint and shade of the same. Such a combination would serve to introduce the subject of Harmony of colours.

It should be pointed out that certain colours "go" much better with some than with others, and that two or more colours which form a pleasing combination are said to be in "harmony".

Various combinations may be used for the exercises of this stage; and to the end that the teacher may properly direct the pupils, and be able to lead them to an appreciation of colour harmonies, one or two simple rules are here given.

Colour harmonies are classified under several heads, and a combination of different tones of one scale of colour, as suggested above, is known as Dominant harmony.

Pattern Making - Standards, Tints & Shades

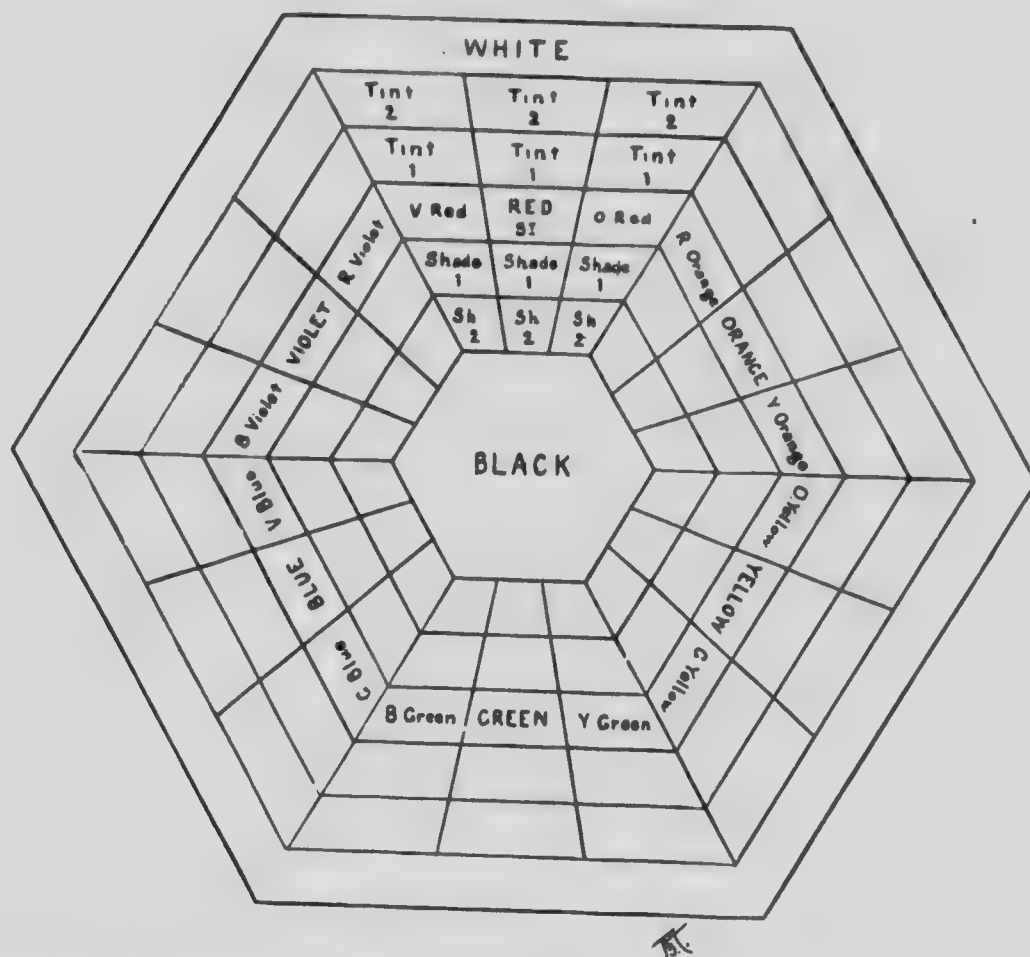


Combinations of pure tones of colour with greys, such as are given for the borders in this chapter, are known as Contrasted harmony. The same term is applied when pure tones of colour are used in conjunction with white, black, silver, or gold.

The Colour Diagram is useful in lessons on Harmony. In it, as may be seen, the colours of the spectrum are arranged

in a regular hexagon, each colour family occupying one-sixth of the area. In the centre of each family group is

### Colour Diagram



the standard colour which darkens by *shades* into black in the centre and brightens by *tints* into white at the outer rim of the hexagon. On the right and left of the standard



colours are the *hues* or intermediate colours of the spectrum, and these also have their shades and tints. Any combination of the standard and its hues, tints and shades will be in Dominant harmony.

Other harmonies may be obtained by taking colours from opposite sides of the hexagon, such combinations being known as Complementary harmonies. In making such combinations the principal colours should be sparingly used, or very crude effects will result.

If other harmonies are desired, they may be found by selecting colours which would form on the diagram an equilateral triangle. Thus a red-orange, a yellow-green, and a blue-violet hue would form a pleasing combination.

Generally speaking, bright colours should be used in small masses, and strong contrasts of colour should be avoided. Such colours as standard yellow, orange, or blue are very useful for border lines and for brightening a design, but should not be used in large masses. Children, like savages, are attracted by bright colours, and careful guidance is needed in the early stages of this work if a proper taste is to be cultivated. A packet of papers of assorted colours and tones should be at the children's service, so that various effects may be tried, and the crudities resulting from ill-harmonious selections of combinations pointed out.

## CHAPTER V

### FOURTH STAGE

(a)

The constructive work in this stage consists of cutting and modelling in thin cardboard. A number of useful articles are given as exercises and will involve mechanical drawing, cutting with scissors, tying with cord, tape or ribbon, and a little pasting.

Cardboard work has been found to be one of the most useful and attractive forms of Manual Training. The materials are cheap and easily obtainable, the appliances are few and simple, and the scope of the work almost unlimited. Opportunities for the application of much of the abstract work of the school are numerous, arithmetic and drawing benefitting especially from it. For the rural school it forms an excellent substitute for bench-work in wood, and for the middle grades of town schools it is an admirable preparation for the more advanced constructive work of the Manual Training room proper.

The appliances required are : (1) A 12-inch flat rule for each child ; these need only be such as are generally to be found in all schools, costing three or four cents each. (2) A pair of small scissors for each child ; good serviceable scissors can be obtained at \$2.50 per dozen. Even these, however, need not be purchased, for most children can bring a pair for one afternoon in the week. It is to be preferred,

though, that the school purchase them if possible. (3) A few set squares, or "triangles," as they are sometimes termed. They can be obtained very cheaply—about four cents each. In class work it is generally advisable to use the two regular shapes, one with angles of  $90^\circ$ ,  $60^\circ$  and  $30^\circ$  and the other with angles of  $90^\circ$  and  $45^\circ$ . In distributing these, the class monitors give the  $45^\circ$  squares to one pupil, and the  $60^\circ$  to the rest, and so on alternately round the class. (4) A fairly hard pencil, H or H H, with a flattened or "chisel" point for drawing fine lines. (5) A few ticket punches, say one for every ten pupils. These may be obtained at a cost of from 15 to 35 cents each, the price depending on the quality. As with all tools, low priced ones are not economical in the end.

The materials are : (1) Some thin Bristol board, 120 lbs., which is made both in white and a variety of beautiful colours. By the hundred sheets it costs from one to two cents per sheet of 22 by 28 inches, smaller quantities being sold at slightly higher rates. (2) Some coarse knitting cotton or macrame twine, and if funds will allow of it, some narrow ribbon of assorted colours. (3) A tube of "photo" or "library" paste.

The opportunities for development of taste in colours should be utilized. The Bristol board is made in many delicate and beautiful colours, though it should be noted that the tones are seldom true and cannot be used in conjunction with the scheme of the earlier work in the coloured papers.

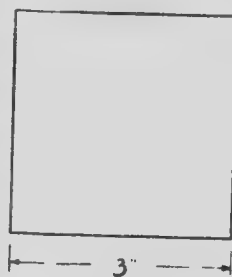
For one or two of the exercises, common wrapping paper is used ; this is, of course, obtainable everywhere.

The preliminary exercises consist of four or five plane figures, commencing with a square of three-inch edge.

## EXERCISE 1. A SQUARE CARD

The drawing of this will involve a talk on the square and its properties and the making of a good line. The children should be led to describe a square and finally to evolve its orthodox definition. On no account should the definition be given straight off by the teacher; it should be pieced together from the various answers and ideas of the pupils themselves. In this way, handwork can be made a useful adjunct to language work, and, as will be shown later, to many other forms of school work. The manipulation of the ruler and set square is a little difficult at first, but is an excellent training for the left hand. The drawings should be made in an ordinary map drawing book or, if more convenient, on separate sheets of paper.

Commence by drawing a very faint line with the ruler from top to bottom of the paper. The chisel point of the pencil must be kept well into the angle formed by the edge of the ruler and the surface of the paper, and a very light pressure used. Now comes the difficulty of holding the ruler and set square so that the latter can be moved along the former to any desired point. As the right hand must be free to hold the pencil, the manipulation of the ruler and set square must be done with the left hand. The ruler must be held firmly with the *little finger* and *thumb* of the left hand, the fingers being left free to hold or move the set square along the edge of the ruler.



EX. 1. A SQUARE CARD.

A minute or two spent in mastering this operation at first will save much time later on.

Having drawn the upright line and placed the set square in position, as indicated in the diagram, place the point of

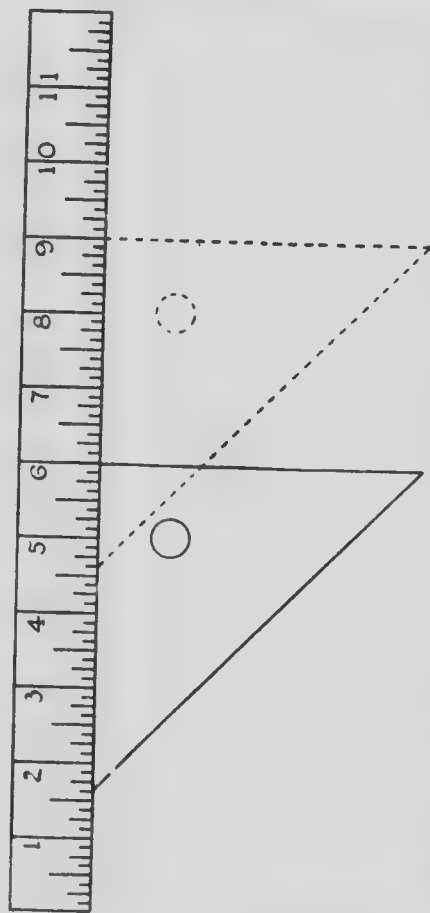


FIG. 1. RULE AND SET SQUARES.

the pencil against one of the divisions of the ruler; *slide the set square up to the pencil*, and draw a faint line at right angles to the first one. Without moving the ruler, slide the set square back the distance required (three inches, in Exercise 1) and draw another faint line. Note that the pencil should always be placed on the point and *the set square moved to it*, and not *vice versa*, if accurate results are to be obtained.

By measuring the three inches on these two horizontal lines, the square is obtained. The actual square may then be lined in with a firm but fine line, and the dimensions placed under, as in the diagram. The title of the exercise should be neatly written or printed above it, Exercise 1 being termed A Square Card.

A little preliminary practice in the manipulation of ruler and set square, and the drawing of lines at right angles, may be required in some cases, but it is better to get the necessary

dexterity by drawing *something* rather than a series of practice lines which come to nothing in the end.

The drawing finished, the pieces of card are then distributed. These should be cut about three-quarters of an inch larger each way than the finished exercise. The drawing should then be carefully made on the card, ready for the cutting out. Next, the proper method of holding the scissors should be demonstrated, for a great deal depends on it. The thumb must be placed in the upper loop, the *middle* and *third* finger in lower loop, with the forefinger in front of it. Holding the card in the left hand, open the scissors *wide* and cut steadily forward on the *right* hand side of the figure, steadying the right arm by holding the elbow close to the side. Do not bring the points of the scissors together; better results are obtained by not cutting with the points, though the children are apt to do so at first. When the first cut is completed, it is well for the children to hold the card up while the teacher passes rapidly round inspecting the cut, pointing out the weak places and approving of the good, straight edges. The other three sides of the square should then be cut and the complete figure *laid* on the drawing to test its accuracy. Great stress should be put on this feature of the work, and from the first no deviation from truth should be accepted by the teacher as satisfactory. At first the cutting may not be all that is desired,

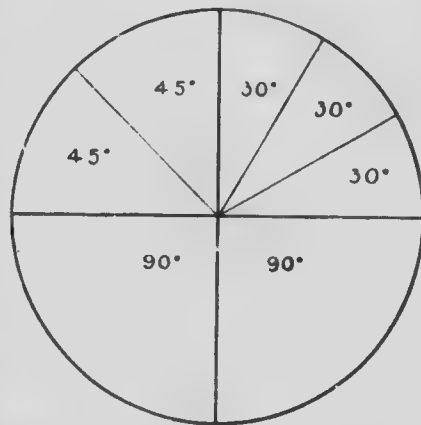
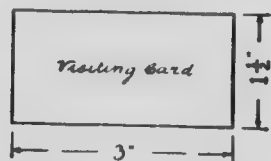


FIG. 2. BLACKBOARD DIAGRAM FOR TEACHING ANGLES.

but the importance of exactitude in measurement should be insisted on. The names of the children should be neatly written on the cards, and the number of degrees in a right angle shown in one corner.

### EXERCISE 2. THE OBLONG

As each new step is to be from the standpoint of something already accomplished, the oblong card is a fitting exercise to follow No. 1. Commence by getting the children to point out, first, the similarities to the square, and then the differences from it. The definition may thus be educed and pieced together from the children's answers as in the first exercise. The drawing presents no new features, except that the half inch is introduced. The size given is that of an ordinary visiting card, and each pupil should write his name neatly upon his card for this purpose.



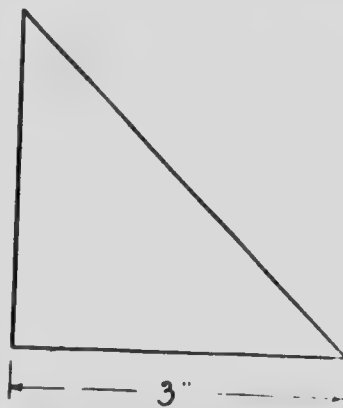
EX. 2. AN OBLONG.

### EXERCISE 3. A RIGHT-ANGLED TRIANGLE

As the base and perpendicular of this figure are to be made equal, the acute angles will, of course, be  $45^\circ$ . By demonstrating with a large sized triangle, cut out of cardboard, lead the children to see that the new figure is half a square. Reviewing the two previous lessons, there should be little difficulty in getting the children to calculate the number of degrees in a triangle,  $90^\circ + 45^\circ + 45^\circ$ , as the acute angles are half a right angle. As a piece of information, they may then be told that *all* triangles, whatever their shape, contain 180 degrees. The drawing is simple, but care must be taken

to get the sides of the triangle exactly equal. In cutting out, the acute angle will involve increased care in commencing the cut along the hypotenuse of the triangle. During the exercise, the meaning of "tri" should, of course, be given, also of the distinguishing adjective, "right-angled."

The teaching of angles, degrees, etc., is much assisted by a simple diagram, which should be drawn on the blackboard during the early lessons, and added to from time to time as new angles are introduced. This is shown in Fig. 2, and should at first be formed of the circle and vertical and horizontal lines through its centre, giving four right angles. Four times  $90 = 360$ , the number of degrees a circle is divided into for the purpose of having a standard by which to measure angles.



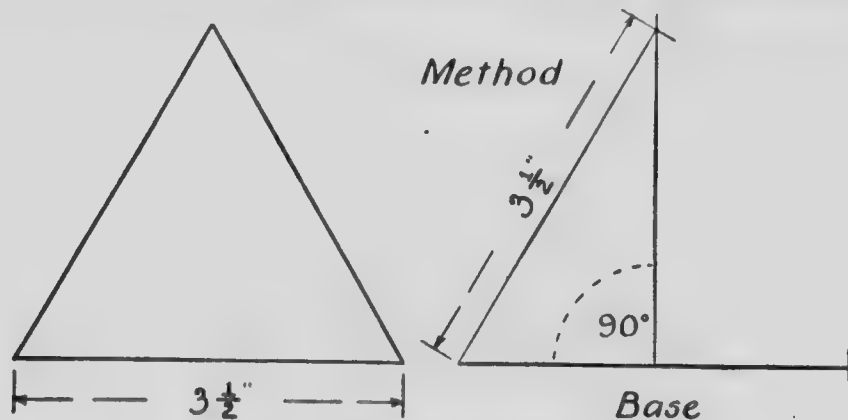
EX. 3. A RIGHT-ANGLED TRIANGLE.

#### EXERCISE 4. AN EQUILATERAL TRIANGLE

Begin by reviewing the last exercise—naming the angles as "right" and "acute," and eliciting the number of degrees in each, and their sum. "All triangles, remember, have  $180^\circ$  in them." That being so, the equilateral triangle having equal angles, the number of degrees in each is easily obtained from the children. To draw the figure, first put in a horizontal line for the base, and from its centre erect a perpendicular by the aid of the set square. Next, measure off from one end of the base a distance equal to it, swinging the



ruler until it meets the perpendicular line. This will give the

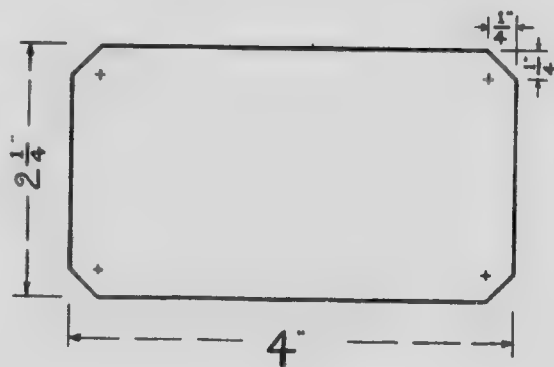


EX. 4. AN EQUILATERAL TRIANGLE.

apex of the triangle, and the figure is easily completed. The cutting out calls for no special remark.

#### EXERCISE 5. A NAME TABLET

This exercise is based on the oblong, and also brings in again, in another form, the  $45^\circ$  right-angled triangle. The oblong should first be drawn with faint lines, then the small triangular pieces measured off, and the actual outline of the tablet lined in. The ticket punch will be needed for this and many of the following exercises. The position of the holes should be indicated in the drawings by

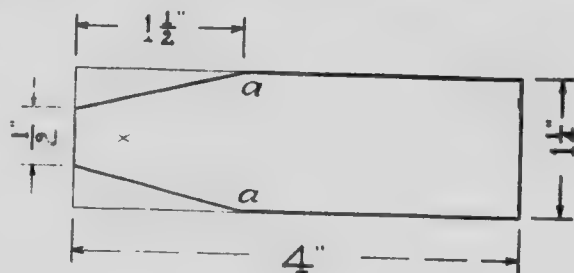


EX. 5. A NAME TABLET.

tiny crosses, and it will be seen that in the present exercise they are located by lines joining the corners after the little pieces have been cut off. In cutting, great care must be taken with these corners, for the children are apt to snip them off at random.

#### EXERCISE 6. A BAGGAGE TAG

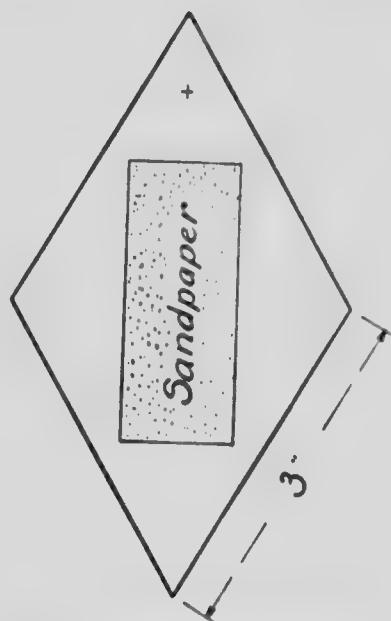
Another exercise based on the oblong. The drawing is simple, but the cutting of the very acute angles at  $a a$  needs care, or the tag will be lop-sided. The hole must be carefully marked — half an inch from the end, and at equal distances from each side. The marking of the half inch in the centre of the oblong, to form the end of the tag, gives an opportunity for a little arithmetic. By a little questioning, and perhaps a sketch on the board, the number of eighths in an inch and a quarter can be elicited from the children, and the margin to be cut off on each side, viz., three-eighths, easily obtained.



EX. 6. A BAGGAGE TAG.

#### EXERCISE 7. A MATCH SCRATCHER

By punching a hole near one end and pasting a piece of sandpaper down the middle, the rhombus shown in the diagram may be made a useful model. The properties of



EX. 7. A MATCH SCRATCHER.

If the oblique lines are parallel, a square is formed in the centre by their intersection, and the portions cut out are also right angles.

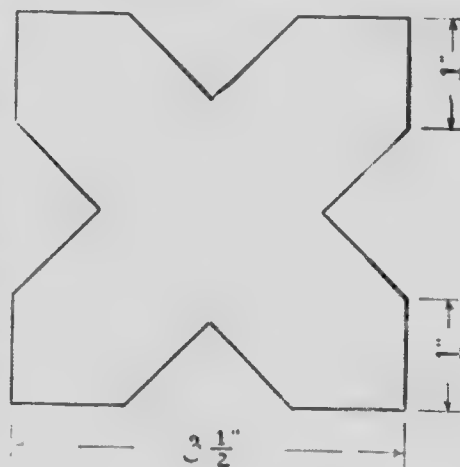
It forms a good drawing lesson if taught so that these points are brought out, as it gives a *repetition of principles*, but a *variety of form*—an important point in any school work whatsoever.

This exercise introduces cutting with the scissors held at the left hand of the line in

the rhombus must be brought out—"a square pushed out of shape"—therefore, it will have four equal sides and two pairs of equal angles. By making its acute angle  $60^\circ$ , the figure is readily drawn by constructing two equilateral triangles about the same base. The cutting out is simple.

## EXERCISE 8. A WOOL WINDER

This is based on the square, but involves very accurate measurement to obtain good results.



EX. 8. A WOOL WINDER.

cutting out the angular pieces. Great care must be taken that the cuts actually meet in the angle, neither going too far nor stopping short and leaving a ragged corner.

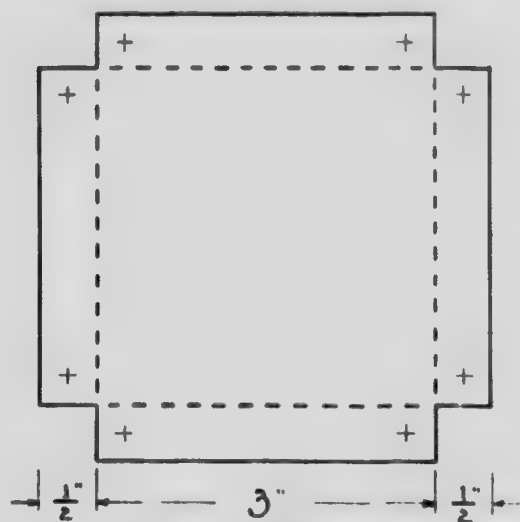
The next few exercises introduce a rather important principle, the "development," or unfolding, of solids.

The first examples consist of small articles formed by the building up, or putting together, of some of the figures with which the children have become familiar in the earlier exercises. The mental process accompanying this work involves, first, the *analysis* of the article to be made, and then its *synthesis*. From actual perception of the development the mind is led to form a mental conception of the finished object, and the reasoning powers are stimulated and developed. Bearing this in mind, the drawing should always be of the "development" of the object, that is, the various parts laid out flat. The drawing of the completed article would involve principles of perspective or projection, far too difficult at this stage.

#### EXERCISE 9. A PIN TRAY

Commence by showing the children a completed model, and then lead them to see that the tray is composed of a square with an oblong on each side. Demonstrate by unfolding the model and laying it out flat before them, and then proceed with the drawing. First draw a square of three inches edge, producing the sides a little beyond at each angle. On each of these produced portions measure carefully half an inch, and then draw the oblongs. If the mere drawing were the objective, it would, of course, be easier to draw a four-inch

square and measure in on its edges to obtain the inner square. This is not recommended, however, as it does not follow the mental process of unfolding the tray involved in the method of drawing as suggested. It



EX. 9. A-PIN TRAY.

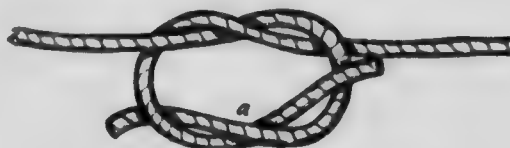
will be noticed that the lines where the card is to be folded are indicated in the drawing by "dotted" lines, as they are usually termed. As these consist, however, of a series of short lines, and not dots, the term is somewhat of a misnomer. They require careful drawing to look neat—regular spacing and regular length of "dots" only being attained after some practice.

With the drawing before the child, the piece of card can be marked and cut out. Care must be taken to cut out the square corner bits cleanly and evenly. Before bending up the sides it is well to take a sharp pencil and score a fine line on the card, using a fair amount of pressure. This will assist in getting an even bend, care being taken to bend *away* from the line. The point of the scissors is sometimes used for scoring, but a sharp pencil does the work fairly well and is safer to use than the open scissors. It is a great help in bending if the smaller portion of the card be held flat on the desk *under the ruler*, while the larger piece is turned up. Care must be taken though, to keep the edge of the ruler exactly on the line of fold.

Next, the holes should be punched, and the corners tied with a neat "square" knot, known to sailors as a "reef" knot, using coarse crochet cotton or macramé twine. A diagram is given of the proper method of tying this knot, also of the wrong way, which produces a hybrid variety, known to nautical men as a "granny" knot. A piece of stout cord is useful for demonstrating to the class the method of tying.



**A SQUARE KNOT. (Right.)**

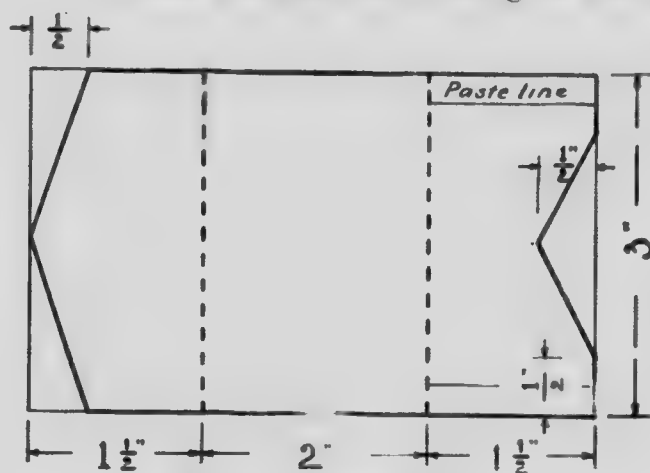


A "GRANNY" KNOT. (Wrong.)

**Note difference in turn at (a)**

### EXERCISE 10. A STAMP CASE

In this exercise the oblong is first drawn ; then the cross



### Ex. 10. A STAMP CASE.

lines for bending ; then the point of the flap and the indentation in the front piece. Cut out and fold on the dotted lines, ready for fastening together. For this exercise the tube of paste will be needed. Squeeze a little out, about the

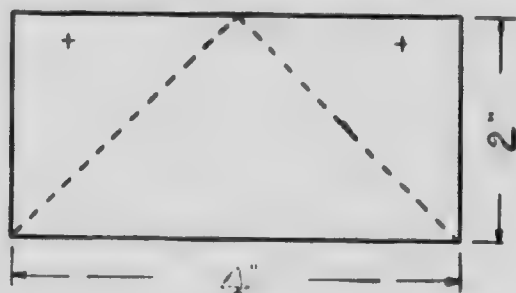
size of a pea, on a slip of waste card, and serve one to each

desk. A brush is not necessary; the best instrument for putting on the paste being a wooden toothpick. A thin, even film can be laid on with it, and the desk, fingers and work kept clean. It is best to draw a line as a guide for pasting, one quarter of an inch from the edge.

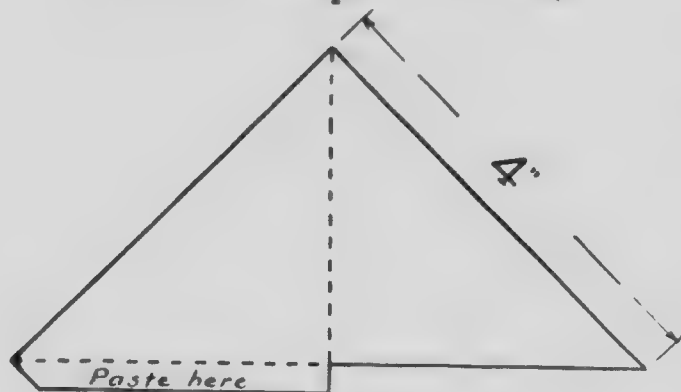
### EXERCISE 11. A BOOK MARKER

Another exercise based on the oblong. The children can

EX. 11. A BOOK MARKER.



be led to see that the corners, when folded about the dotted lines, will meet. Punch the holes and tie with a bow. If funds admit, "baby" ribbon is much more effective than the cotton for this.



EX. 11a. SECOND METHOD.

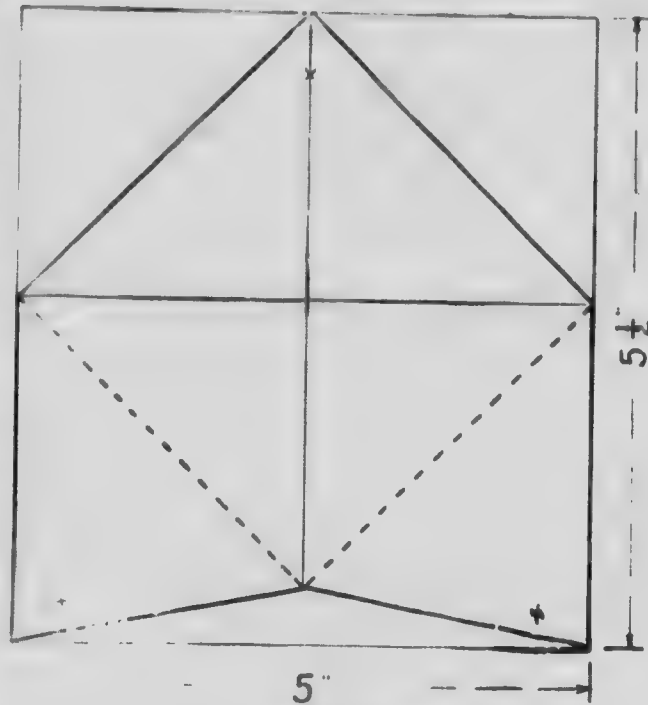
#### EXERCISE 11a.

An alternative form of the book marker is made by pasting, instead of tying. The development is given and explains itself.

A small spray of flowers, or other simple design in water colour, makes a good decoration.

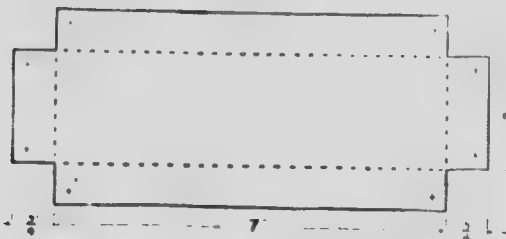
## EXERCISE 12. A WALL POCKET

The book marker is folded to meet and lay flat. This exercise has similar flaps, but they must be *more* than half a square, or the wall pocket will not hold anything. Draw an oblong 5 by  $5\frac{1}{2}$  inches, and at  $2\frac{1}{2}$  inches from one end of it draw a line to form the diagonal of the square, as shown in the diagram. The rest of the drawing is obvious.



EX. 12. A WALL POCKET.

## EXERCISE 13. A PEN AND PENCIL TRAY



EX. 13. A PEN AND PENCIL TRAY.

This is similar to the pin tray, but the greater length renders the cutting more difficult. After bending and tying the corners it may be found that the sides have a tendency to curve outwards.

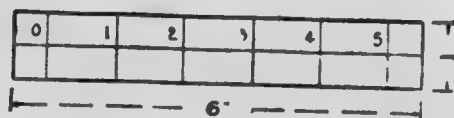
If so, it is because the card has not been bent *well beyond*



the right angle in the first place, which would have prevented its springing out afterwards.

#### EXERCISE 14. A CIRCLE MARKER

Several of the succeeding exercises will necessitate the drawing of a circle. The lack of compasses need not be a bar to this as fairly effective work can be done by means of a strip of card and a common pin. Cut out a strip six inches by one, and divide as shown in the drawing. Number from 0 to 5, and pierce a hole with the pin at



EX. 14. A CIRCLE MARKER.

each division. To draw a circle, place the pin at 0 and the pencil through one of the holes at the proper distance required. Then stick the pin firmly into the paper or card, and draw the circle.

#### EXERCISE 15. A CANDY BASKET

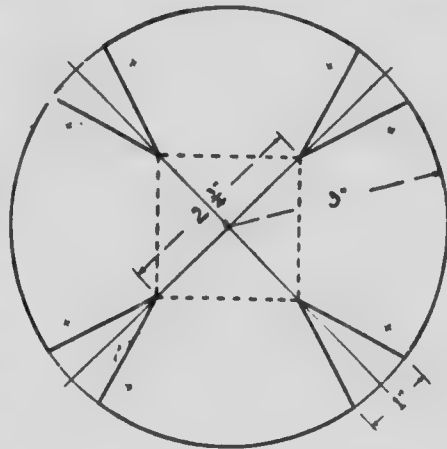
The circle marker will be required in this exercise, and a short talk on the properties of the circle should be given. The centre, radius and diameter should be defined in a simple way, such as by saying that the circle we are going to draw is six inches in diameter. The children will readily see that the distance *must* be measured through the centre, and that the radius is exactly half the diameter.

Commence the drawing by describing a circle of six inches in diameter. Then draw two diameters at right angles to one another. Mark off on these a square having diagonals of  $2\frac{3}{4}$  inches to form the bottom of the basket. The shape of the triangular pieces to be cut out is obtained by measuring half

an inch on each side of the extremities of the diameters of the circle.

The correlation of the handwork with the ordinary work of the school must be kept steadily in view by the teacher, and advantage taken of the manifold opportunities for illustrating many of the abstract subjects by the manual training work.

In most well-arranged drawing courses a place is given to scale drawing, largely on account of the mental training it affords. Several of the succeeding exercises offer good opportunities for concrete work in scale drawing, and its use and necessity can easily be shown. In the lesson introducing it, the teacher may refer to maps, to a plan of the room drawn on the board, etc., as showing the necessity for making drawings of large objects to a smaller scale. The children will also readily see that in some instances, such as parts of insects in nature-work drawings, things have to be drawn on a larger scale than their actual size, if we wish to represent them by a drawing. A few examples will help to make the idea clear to the pupils. The door of the room may be drawn on the blackboard to a quarter scale, that is, one-fourth the real size. Give the children the actual size, or, better still, let a couple of them measure it, and let the rest tell the teacher the size it will be reduced to on the black-



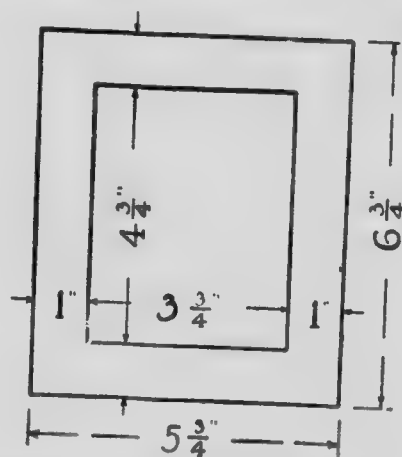
EX. 15. A CANDY BASKET.

board. "How wide?" "How high?" etc. Other familiar objects can be chosen and the practice in mental arithmetic made extremely helpful.

### EXERCISE 16. A CABINET PHOTO FRAME

As the drawing of this is merely of two oblongs, one within the other, it forms a good exercise for a first attempt at scale drawing. Show the children the finished exercise and lead them to see that they can save a great deal of space by making drawings to scale of the larger objects of the course. Next the scale must be decided on, say, one-half full size. After writing at the top of the page the number and name of the exercise, the date, etc., the scale should be indicated thus—

Scale =  $\frac{1}{2}$  size.



EX. 16. A CABINET PHOTO FRAME.

On no account should this be omitted from any scale drawings. Next, the actual size of the frame should be given and the children asked what size *they* will draw it. This is, as remarked above, an opportunity for mental arithmetic, and the questions may be varied. "How large would your drawings be if we made them to quarter scale?" "How large will my blackboard drawing be if I make it four times the scale?" and so on. The outline being drawn, the width of the margin should be given, the dimensions of the opening calculated (or *vice versa*) and the drawing completed.

Drawing to scale will necessitate the "dimensioning" of their drawings by the children, if it has not been already practised. The orthodox method of dimensioning is shown in the illustrations, but sometimes a faint line, broken in the middle for the figures, is drawn better by small children than the usual half inch "dash" (—) line as shown. The inches are indicated by two tiny strokes after the figure, as in the illustrations.

For the practical work of Exercise 16, two pieces of card are needed—a plain piece for the back and a piece of fancy or tinted board for the front.

The cutting out of the opening is quite a new operation and a little care and ingenuity are required in doing it. Commence by piercing a hole with the scissors about the centre of the oblong which is to be removed, and then cut along the diagonals to each angle. After this has been done, it is much easier to cut along the lines to complete the opening neatly. It will also be found that much better results are obtained if the scissors are held *underneath* the card in cutting the opening. The teacher will, of course, have practised on one or two beforehand, and the methods suggested above will be seen to be the best. Three edges of this front piece are then pasted for a quarter inch from the margin and pressed carefully in position on the card forming the back. The illustration shows the frame as an upright one, but it is a good plan to allow the children to choose individually whether they will hang it the other way. If so, the holes for the cord or ribbon will, of course, be punched on one long side instead of as shown. In either case three edges only must be pasted, the frame being left

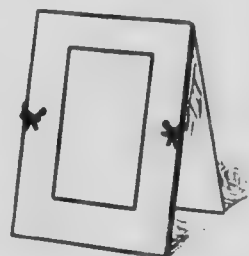


MODELLING IN THIN CARDBOARD.

open on one *side* to allow of the photo being slipped in. The holes should be punched *after* the front is pasted to the back.

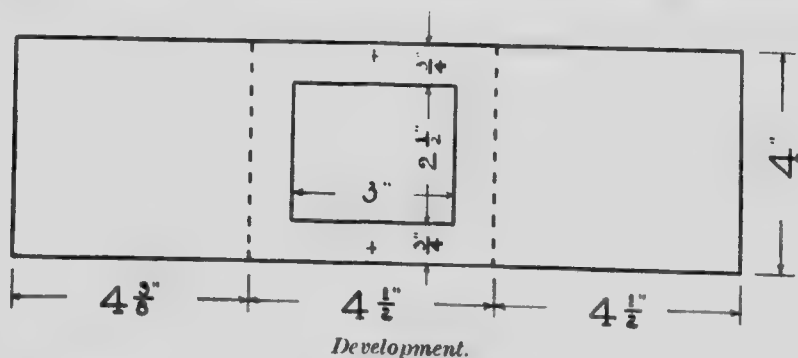
### EXERCISE 17. A SMALL STANDING PHOTO FRAME

The drawing of this model will involve the principles of development and scale drawing in combination. The teacher's model should be shown and commented on, then unfolded and laid out flat. It will then be seen that the three portions form one continuous strip, and the drawing may be commenced by making an oblong to represent it. In deciding on the size of this, the children must be led to calculate the length of the unfolded card, etc., and also the size it must be drawn when reduced to the scale decided on. It is so much easier to *tell* the children this, that this note of



EX. 17. A SMALL  
STANDING PHOTO  
FRAME.

Note.—Pupils draw the  
development.



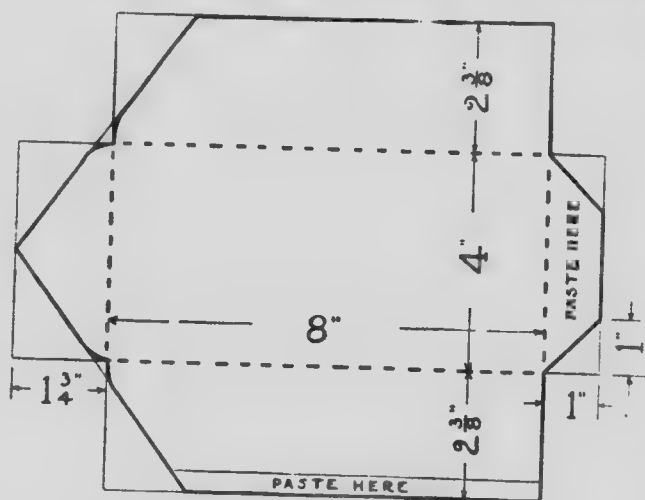
warning needs to be sounded, so that the work may not descend to mere mechanical manipulations. Head and hand

must work together if the full benefits are to be obtained from manual training, and it should be an axiom with teachers that *it is uneducational to do for the children what they can do for themselves.*

The cutting out of the opening is more difficult than the larger one in Exercise 16, but can be managed with a little care. As in the last, the scissors must be held *underneath* the card, and an incision first made near the middle. Then cut toward each angle and gradually remove the waste and cut the opening to the exact size. The front and middle pieces are tied with neat bows of cord or ribbon, and the back piece left to form a leg or rest to enable the frame to stand up.

#### EXERCISE 18. AN ENVELOPE

This may be made any convenient size, but it is a



EX. 18. AN ENVELOPE.

good plan to make it rather large. An envelope of the size given takes the monthly "record" sheets used in some schools, and serves to keep the sheet clean when being carried home for the parents' inspection. Common wrapping paper, to be obtained at any

store at almost nominal prices, is used for this exercise

The drawing is more difficult than in Exercise 17, though the principle is the same. Commence by drawing the oblong in the centre of the paper and build the sides, ends and flaps on it. As in the two previous exercises, a great deal of mental work is involved, and the remarks on that side of the work apply particularly to this exercise.

The cutting out is simple but the creasing must be very carefully done. Care must be taken, too, in pasting the edges, or an excess of paste will squeeze out of the joints and stick the front and back of the envelope itself together. The best way is to hold the edge to be pasted on the edge of the desk, working the paste in an outward direction. This will prevent paste being scraped off by the edge of the paper and getting underneath it.

#### EXERCISE 19. A HEXAGONAL TABLE MAT

This exercise will introduce the drawing of the hexagon, a more difficult plane figure than any of the preceding ones. There are several methods which may be used for the construction of the figure, the simplest, perhaps, being that of the circumscribing circle. Compasses are an advantage in this, but, as in the case of the circle and exercises based upon it, the slip of card (Ex. 14) will serve the purpose.

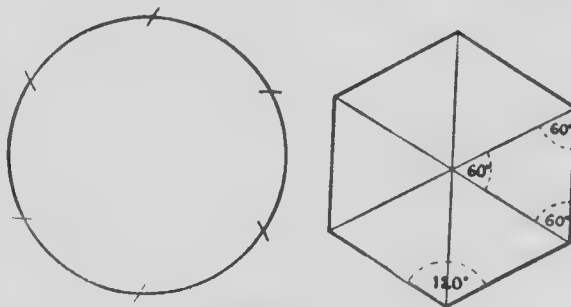


DIAGRAM A.



Commence, then, by reviewing the lesson on the circle and then point out that the radius will step round the circle exactly six times. After drawing the circle, place the pin on the circumference and with the pencil in the same hole used to draw the circle, mark off a small arc cutting the circumference. Transfer the pin to this new point and repeat the operation and so on round the circle. By joining the points thus obtained, the hexagon is constructed. The number of degrees in the angle of a hexagon can next be discovered by drawing the three diagonals. This will cut up the figure into six equilateral triangles, and by reviewing the early lessons, the angles of these are shown to be sixty degrees. As two of these are contained in the angle of the hexagon, the children will readily see that it will be  $120^\circ$ . The diagram A will make this clear.

A purely mechanical method is to use the  $60^\circ$  set square, and to this there is no objection, provided that the children understand why the hexagon can be obtained by its aid. In

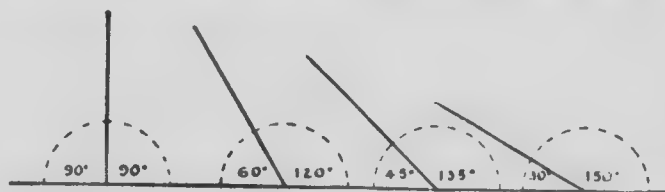


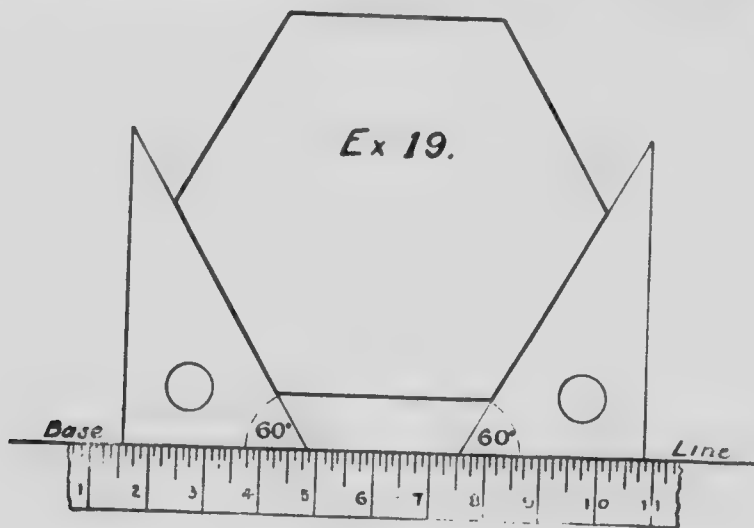
DIAGRAM B.

either case the diagram suggested for the circle method should be drawn by the teacher on the blackboard,

and the properties of the hexagon worked out. The set square method depends on the size of the exterior angle of the hexagon. By producing one side of the figure, a little judicious questioning and demonstrating will enable the children to calculate the number of degrees in the exterior angle. For instance, by drawing a straight line and a perpendicular

to it, two right angles, or  $90 + 90$  are obtained. If the line be not perpendicular, the sum of the angles is still  $180^\circ$ . The interior angle of the hexagon being  $120^\circ$ , the exterior must be the supplement  $= 60^\circ$ . (Of course, such terms as complement and supplement need not be used with children at this stage.) A few illustrations, such as are shown in the diagram *B*, will make this clear, and afford another opportunity for some mental arithmetic.

To construct the figure with the set square, commence by drawing a base line across the paper. Then, parallel to that, draw one side of the hexagon just above it. Further explana-

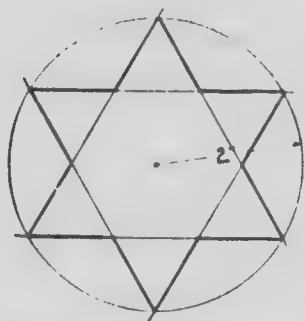


tion than that afforded by the diagram is scarcely necessary; the second and third sides are drawn by the aid of the set square as shown, and made equal in length to the first. By sliding the square along, the fourth and fifth sides can be drawn, and the sixth, parallel to the base, will complete the figure.

Either of the foregoing methods will suffice, but a variant of the first is to give one side of the hexagon and construct on it an equilateral triangle. The apex of this gives the centre of the circumscribing circle, and the other points are obtained as before.

The cutting out is simple, but a bright colour is advisable for this exercise, as it may be used for a vase stand against a dark cloth or table.

#### EXERCISE 20. A SILK WINDER



EX. 20. A SILK WINDER.

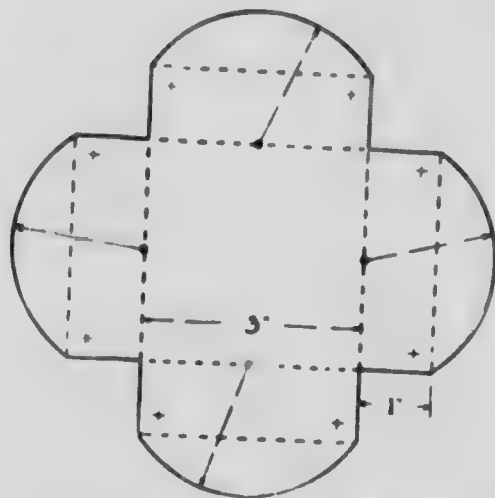
This is based on the hexagon, the six-pointed star being obtained by joining alternate points round the circumscribing circle. The children should note that by joining the inner angles a small hexagon is obtained. The cutting requires care, both at the delicate points and in the angles, but nothing absolutely new is involved.

#### EXERCISE 21. A SQUARE TRAY WITH ROUNDED EDGES

The top edges of this tray are folded over at right angles to the sides; this adds to the appearance of the tray and also stiffens the sides. The drawing should be the development, as shown, and may be commenced by drawing the square for the bottom. Then the oblongs for the sides are added and the curved portions drawn on these. The centres from which the curves are drawn are indicated in the diagram and are found by bisecting the sides of the square. The

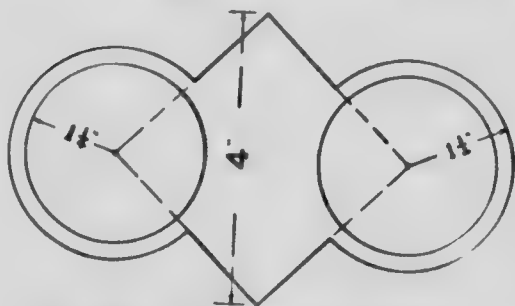
radius is measured from the points thus obtained to the angles of the oblong.

In the practical work, very accurate drawing and cutting are necessary. The creasing is in opposite directions, so that the sharp pencil lines for bending the flaps must be on the opposite side of the card, although of necessity they are shown (dotted lines) on the same side in the diagram. After cutting, punch holes as indicated by the crosses and tie with cord or ribbon.



EX. 21. A SQUARE TRAY, WITH ROUNDED EDGES.

#### EXERCISE 22. A TABLE MAT FOR CRUETS OR "SHAKERS"



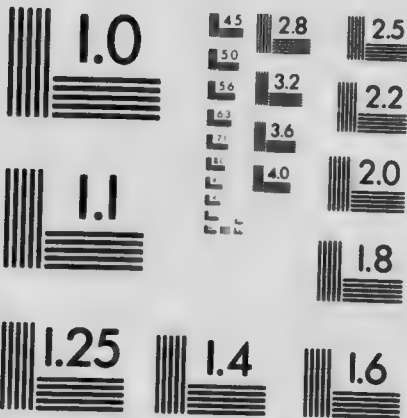
EX. 22. A TABLE MAT FOR CRUETS OR SHAKERS.

The drawing of this gives an opportunity for constructing a square when the length of its diagonal, instead of the side, is given. The centre lines should be drawn first, at right angles to each other. The semi-diagonal of the square can then be measured on them and the square completed. From two opposite corners of the square as centres, the circles



# MICROCOPY RESOLUTION TEST CHART

(ANSI and ISO TEST CHART No. 2)



**APPLIED IMAGE Inc**

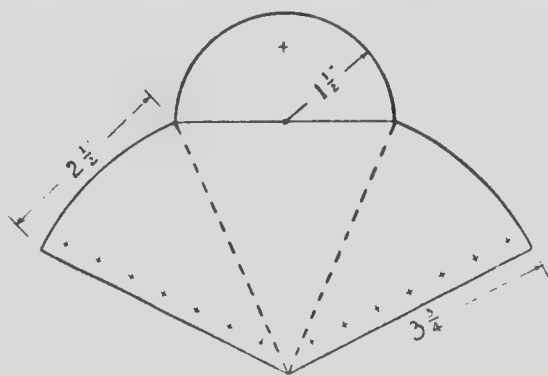
1653 East Main Street  
Rochester, New York 14609 USA  
(716) 482 - 0300 - Phone  
(716) 288 - 5989 - Fax

forming the ends are then drawn. The cutting of the portions of the circles near their intersection with the square will need some care, or a "crippled" curve will result. The inner circle is cut from a piece of white paper and pasted on the cardboard base. This requires very careful and neat manipulation, and thus affords good training; it also improves the appearance of the finished exercise.

### EXERCISE 23. A WALL POCKET

The back of this exercise is formed of an isosceles triangle, with a semicircle on its base.

The drawing should be the development, as shown, and is quite simple. The isosceles triangle can be defined and drawn first, the curved top being added. With the apex of



EX. 23. A WALL POCKET.

the triangle as centre and the length of its side as radius, describe an arc on either side of the back. Measure off the distance given on these arcs and complete the two triangles to form the front of the pocket.

After cutting out and creasing carefully along the lines as shown, the holes may be punched and the fronts laced together with white or coloured cord. A hole is also required for hanging the pocket up, as indicated by the cross. In this exercise care must be taken to get the construction

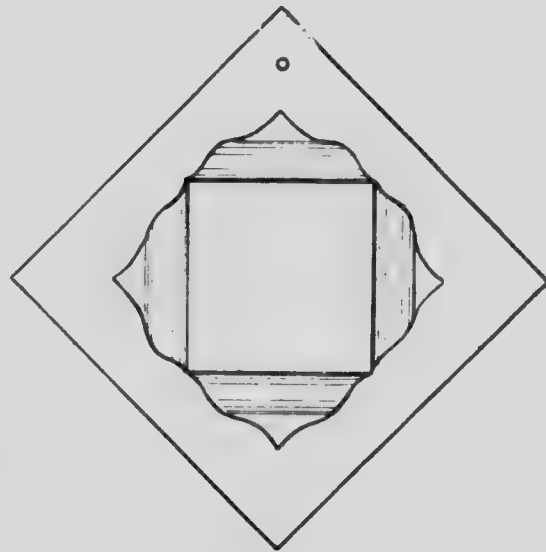
lines on the *back* of the model, so that they will not show when the pocket is hung up.

#### EXERCISE 24. A FANCY PHOTO FRAME

This is an attractive model, but somewhat difficult. The drawing is simple, but the cutting and sticking are troublesome. It is, however, within the power of most children to overcome these difficulties, and the result is a pleasing article. The back is formed of a piece of plain card, and the front of coloured paper. If the latter is coloured on one side only the effect is very good when the corners are turned back.

Draw as shown in the diagram, commencing with the square. Find its centre by the intersection of its diagonals, or by measurement, and then draw the cutting lines parallel to the sides of the square.

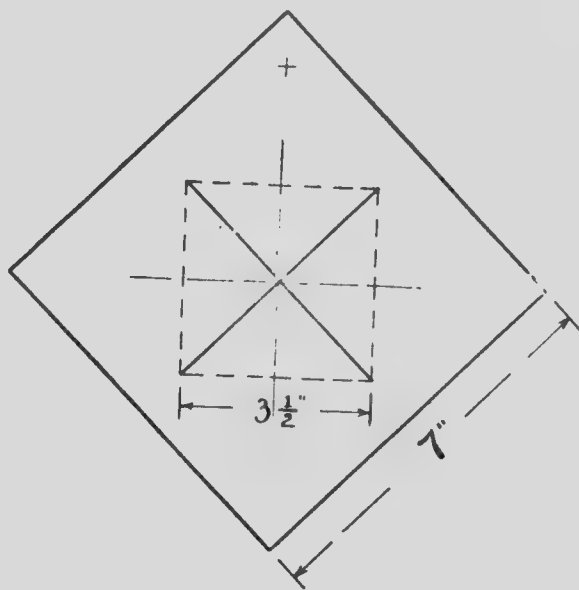
The practical work may be commenced by cutting out the back from a piece of plain or coloured cardboard. Then a square of fancy paper should be cut and the lines for the opening carefully drawn upon it. Then the difficulty of commencing the cut will occur. In the previous frames the



EX. 24. FINISHED MODEL.



scissors could be stuck through the centre of the opening and cuts commenced. As there is no waste removed from this opening, and the corners of the triangular pieces will show when turned back, it is obvious that another method must be used. Take the piece of paper and crease it at the centre,



EX. 24. WORKING DRAWING.

and for a little distance on either side of it. Then, pinching it firmly, cut the double thickness along the line. (It is easier to crease the square right across, but the portions uncut spoil the appearance of the model afterwards.) When one of the cuts is started in this way, the rest are easy. The next step is to paste three edges of the paper and attach it to the cardboard back. When that

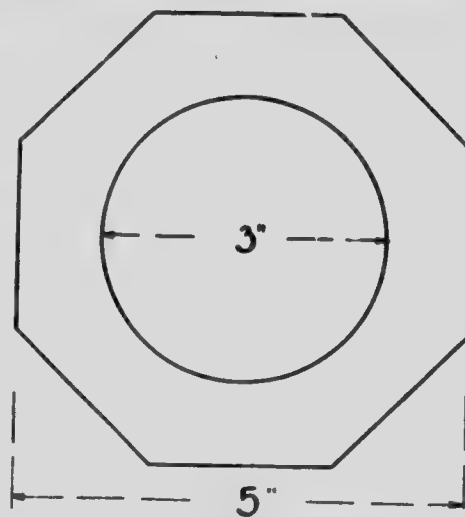
is sufficiently "set," put a tiny dab of paste or glue on the corner of one of the centre pieces and fold it, over a lead pencil, down against the face of the model. Repeat with the other three, punch a hole in one corner for hanging up, and the model is complete.

An alternative method of fastening the corners is to use tiny brass paper fasteners. These are very effective and easy to use. Of course, the size of this frame, or, indeed, of any of the models, may be changed at pleasure. Note that Bristol

board is not suitable for the face of this model on account of the difficulty of curving the corners. Coloured paper should be used instead.

#### EXERCISE 25. AN OCTAGONAL TABLE MAT

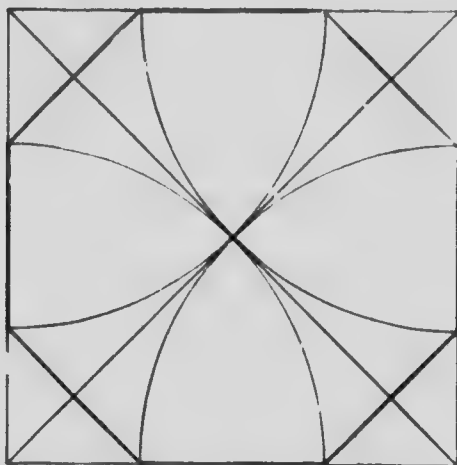
This exercise is an introduction to another simple polygon, the octagon. There are several methods of constructing the figure, but perhaps the best is that of the circumscribing square. Draw a square of the required size, and its diagonals. With the compasses on the angle of the square and radius equal to the semi-diagonal, describe an arc. Repeat from each angle and the points of the octagon are obtained. The diagram makes this clear, though probably this simple method is known to most teachers.



EX. 25. AN OCTAGONAL MAT.

Another method is to draw a circle and vertical and horizontal lines through its centre. The resulting right angles can then be bisected and the circle divided into eight equal parts. By joining these points an octagon is of course easily obtained.

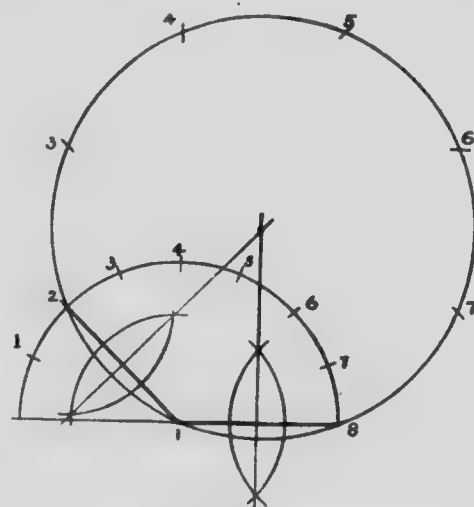
If, however, the children have grasped the previous lessons, one edge of the octagon can be given, and the  $45^\circ$  set square used in the same manner as the  $60^\circ$  set square was used to draw the hexagon.



FIRST METHOD OF MAKING AN OCTAGON.

sides. Then a line drawn through the *second* division of the semicircle gives the exterior and interior angle of the required polygon. The figure may be completed by copying the angle thus found at the other end of the given side, or the two sides may be bisected, and the intersection of the bisecting lines will give the centre of the circle which will circumscribe the polygon. The length of side can then be stepped off on this circle and the figure drawn.

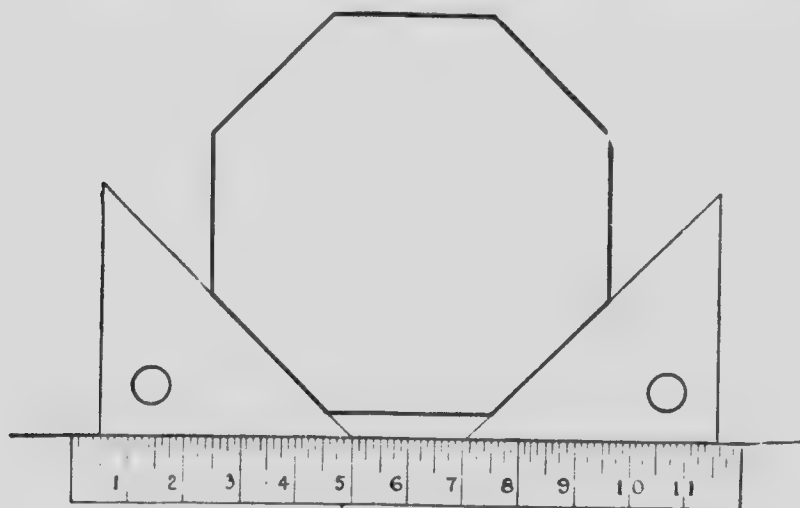
One other method for describing an octagon is given. It is useful, as the principle can be applied to any polygon. Commence by drawing one side of the polygon and produce it in one direction. From one end of the given side as centre, and the length of the side as radius, describe a semicircle. Divide this semicircle into the same number of parts as the figure is to have



AN EASY METHOD OF DRAWING ANY POLYGON.

NOTE.—As the octagon is used in several stages of the work outlined in this volume, the method of drawing should be varied from time to time.

The practical work of this model is very simple, but may be varied by cutting out a circle, or a smaller octagon,



METHOD OF DRAWING AN OCTAGON WITH SET SQUARE.

of white paper and pasting it on the larger octagon as a centre piece.

#### EXERCISE 26. A HANGING LETTER CASE OR POCKET

Two forms of this are given, and either may be taken. The curves at the top are portions of circles, but it may be worth while to try freehand curves in some cases.

Commence the drawing by a rectangle  $8\frac{1}{2}$  by 6 inches. Measure down from the top  $1\frac{1}{4}$  inches and  $2\frac{1}{2}$  inches, and draw faint lines across. On these lines the centres of the arcs used to form the ornamental tops are found. The terms arc, semi-circle and quadrant can be illustrated in this model.

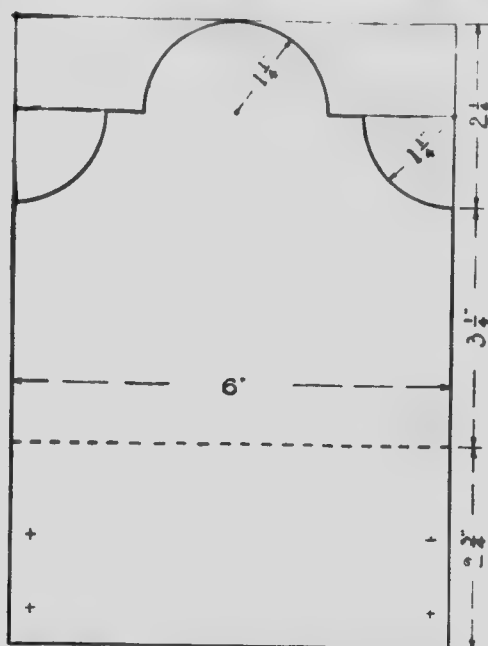
The small curves will prove difficult to cut, but a little care will enable the children to accomplish them neatly and

evenly. The holes are marked only on the portion which turns up to form the pocket. This and the back are bunched simultaneously after folding together.

In tying this model it is a good plan to place a ruler on edge between the front and back portions, and to tie over the ruler. This will give the same length of cord or ribbon on each side.

EXERCISE 26*a*, the alternative form of 26, varies slightly in the drawing, and is perhaps a little more difficult.

Commence with a rectangle of nine by six inches and a faint line across it, two inches from the top. Find the centre



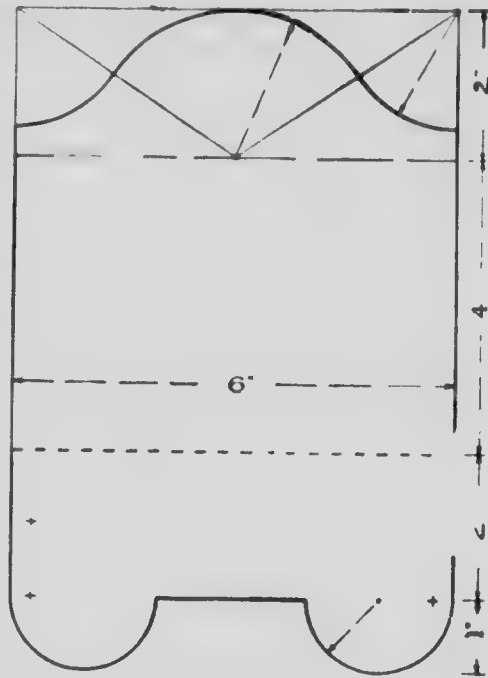
EX. 26. A LETTER CASE (TO HANG).

of this line and join it to the upper corners of the rectangle. With a radius of two inches draw the middle of the curve, as shown in the diagram. Then, from the upper corners of the rectangle, and radius to meet the first curve, complete the curves. This exercise can be better drawn with compasses, as great care must be taken to prevent an uneven junction of the curves. The front portion forming the pocket has two semicircles on it, but the diagram makes the method of drawing these quite clear. The cutting is similar to that of Ex. 26, but great care is necessary in cutting the compound curves at the top.

The cutting is similar to that of Ex. 26, but great care is necessary in cutting the compound curves at the top.

This concludes the constructive work of this stage, and in the majority of cases it will be found that quite sufficient has been given for a class of, say, Grade IV or V children for a year's work, especially if the drawing be properly done. One point, however, must be insisted on here; that is, the *individual* character of all handwork in schools. Some children have greater natural skill and make more rapid progress than others, and it is these children who can be the greatest help or the greatest worry to the teacher who is beginning any form of handwork. It is well, therefore, for the teacher to be prepared with a few exercises or models which may be inserted as extra work for the quicker children. Original designs should be encouraged and the children's

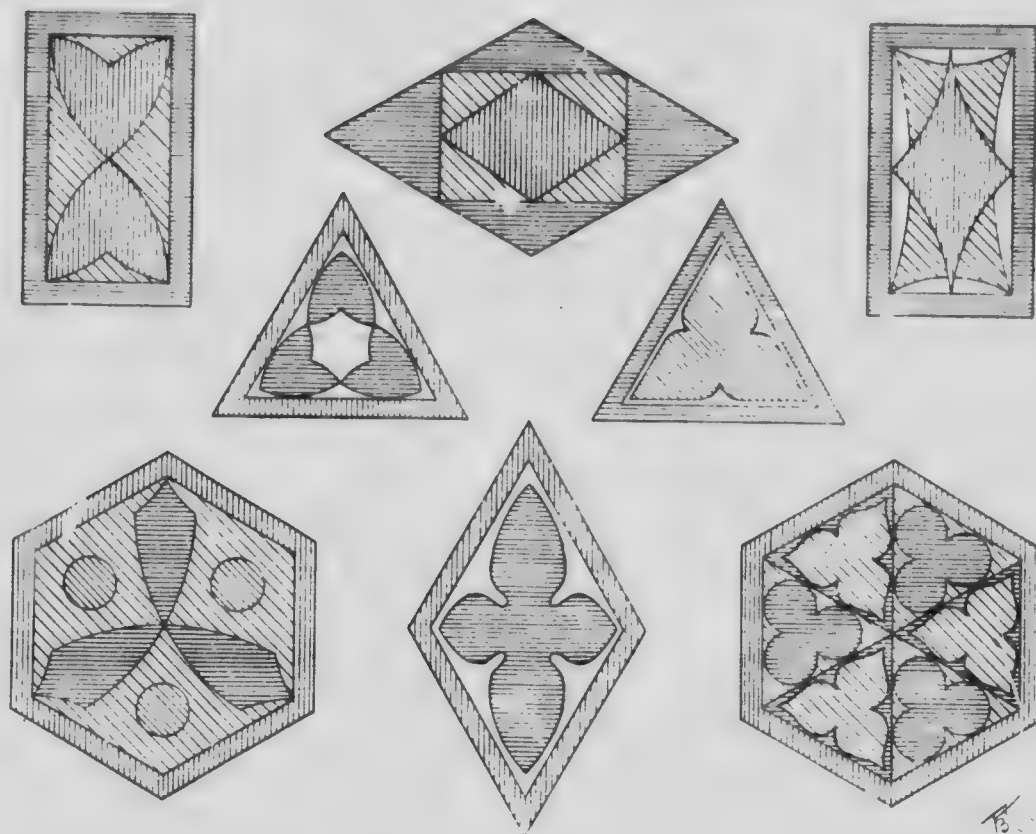
inventive faculty thus developed. The writer has found it an excellent plan to have a day set apart, say once in three months, on which, instead of the regular models, the children may make whatever article they desire. The course outlined in these pages need not be rigidly adhered to, but the teacher must use his or her judgment, and many suggestions for exercises will occur to the thoughtful instructor. Care must be taken, however, to analyze the progression of the exercises.



EX. 26L. ALTERNATIVE PATTERN OF 26.

The work must proceed strictly on educational lines— from the simple to the complex,— building to-day's lessons on the previous ones, taking care, though, to add some new difficulty.

### Designs in Coloured Paper



some new aspect, perhaps, of an old principle, in each fresh exercise. By this means mere mechanical manipulation is avoided and the mind of the child is constantly and healthily stimulated and developed.

*(b)*

The colour work and design of this stage will deal with the various plane figures which have been taught in the constructive work.

The filling of the triangles and polygons with simple designs to be carried out in coloured papers, crayons or water-colours, will carry the pupils a step further in their artistic work, and afford many opportunities for the cultivation of their taste and ingenuity.

The diagram gives some suggestions for this work, the various figures being cut out of plain cardboard and the designs mounted upon them. The remarks upon colour harmonies, etc., in the previous chapter apply particularly to these exercises, which can be carried out with various pleasing effects.

In an earlier chapter it was also recommended that the patterns should be first worked by the pupils as large free-arm drawings upon the blackboards. In this way, various schemes for filling the spaces may be tried, and after the pupil's designs have been approved, they may be drawn upon paper to the proper size, and then carried out in the coloured papers, or other mediums.



## CHAPTER VI

### FIFTH STAGE

THE cardboard construction in this stage is similar in design and principles to the work of the previous chapter; but with the experience gained during the working out of the simpler models, much more ambitious work may be attempted and more complex manipulations be included in the various exercises.

The development of the constructive faculty of the pupils; the training of their reasoning powers by the concrete application of much of their abstract work in arithmetic and drawing; the acquiring of deftness and skill of the hands and the corresponding growth and quickening of the brain cells controlling them; the training in neatness and accuracy; the discipline of will power involved in the task of striving with the difficulties of the exercises; the training of the eye to appreciate form; the joy and strength that comes of *doing*; these and many other attributes will be found to belong especially to this form of manual training. To the rural teacher struggling with a large mixed school and to the town teacher in a fully graded school, it will be found equally helpful. Children and teachers turn with relief to something that is not so much a task set the pupils, as a something they *want to do*. With the motive coming from *within* the pupil, the teacher's task is incomparably easier.

The drawing materials and other instruments used are the same as in the earlier models, but for this course there are two new appliances that are indispensable, the cardboard knife and a cutting board or pad to protect the desk tops. For the thicker cardboard used in the models, scissors will be found of little use, and a knife of some sort is necessary. In the hands of a skilful adult the ordinary pocket knife may answer, but for children a broader pointed, and therefore safer, shape must be used. Many forms have been suggested and tried, but the writer prefers the shape shown in Fig. 1. The cutting edge is at *a*, and the edges *b b* are quite thick and blunt, thus allowing the knife to be held close down, precisely as a pen is held in writing. Such a knife will be found to serve for *any* thickness of cardboard or, if kept in order, will cut the thinnest paper.



FIG. 1. KNIFE AS HELD IN CUTTING.

The cutting board is a piece of common "strawboard," usually of a straw or buff colour, the sort that is used for making packing boxes. A piece about twelve or fourteen inches square is large enough for any of the exercises and will last for a very long time.

The cardboard used in most of the models is of the thickness known as "six-ply," and may be white, grey, or fancy, at pleasure. A fairly good quality is necessary, as the common pulpy grades of cardboard do not bend well, but give a poor, ragged angle.

Some gummed bookbinder's cloth for binding the edges and angles of the models will be needed. If it cannot be

obtained ready gummed, it can be pasted by the pupils as required. The writer has tried both ways of using it, and considers the gummed cloth superior, as the children keep their work cleaner than when using paste.

Even better than the strips of bookbinder's cloth is the linen binding material known as "Styk-um-phast," which can be obtained in a variety of colours, but must be specially ordered to be cut half an inch wide, the sizes sold by stationers being too wide for cardboard work.

Sometimes gummed paper is used, and proves quite satisfactory for binding edges and angles, but is not strong enough for the backs of folios and hinges of boxes, etc., in some of the later models, bookbinder's cloth being necessary in those cases.

A bottle of liquid glue and one or two small pieces of sponge will complete the outfit, if the rulers, set squares, etc., used in the elementary work are still available. If not, these must be procured, as the drawing is of quite as much importance as ever.

#### EXERCISE 1. A TABLE MAT

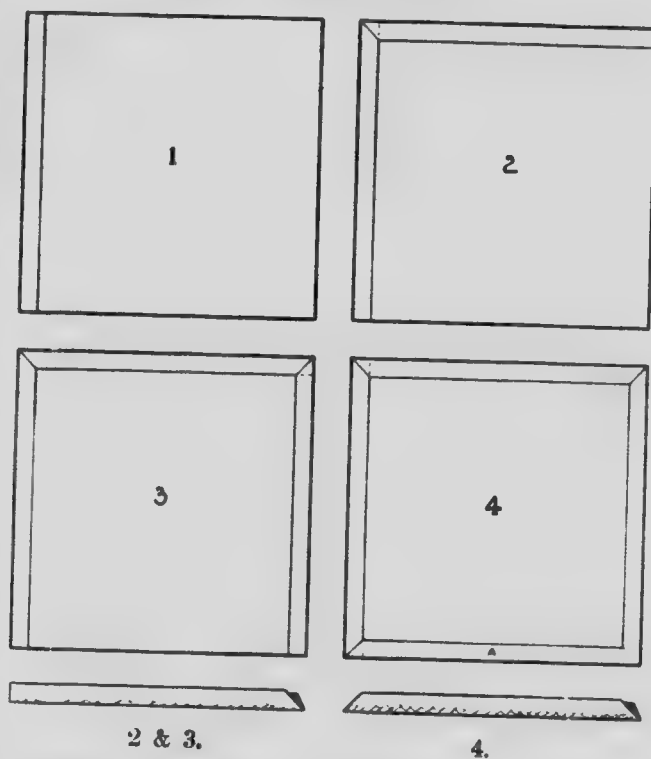
For the first exercise, a simple four-inch square is suggested, as it will involve in very simple form the two new operations of cutting with the knife and binding the edges. The drawing should be of the finished exercise, which may be called a table mat. Care must be taken that the lines showing the binding on the edges are exactly parallel, and that the margin is the same on each edge of the square. Any error in these details will cause the "mitre," that is, the

joint in the binding which bisects the angle, to look very bad on the drawing.

For the practical work, proceed as before by first drawing the square very carefully on the cardboard. Then lay the piece of cardboard on the cutting board and place the ruler in position along one of the lines, holding it firmly with the left hand, and with the knife held *like a pen* (not gripped in the fist) make a cut steadily along the edge of the ruler. Remember that two or three light cuts are more effective than one heavy cut, which will perhaps sever the card at one stroke. Be careful, though, not to move the ruler between the strokes of the knife, but to hold it firmly and evenly until the piece is cleanly and completely severed. If your rulers have one edge bevelled off, do not use that for guiding the knife—the square edge is better and safer.

The first attempts at using the knife may not be quite

FIG. 2. BINDING A MAT.



BINDING PIECES, CUT AND FITTED; FOR EX. 1.

successful, but the muscular sense will soon be developed and the pupil will know exactly how much force to employ.

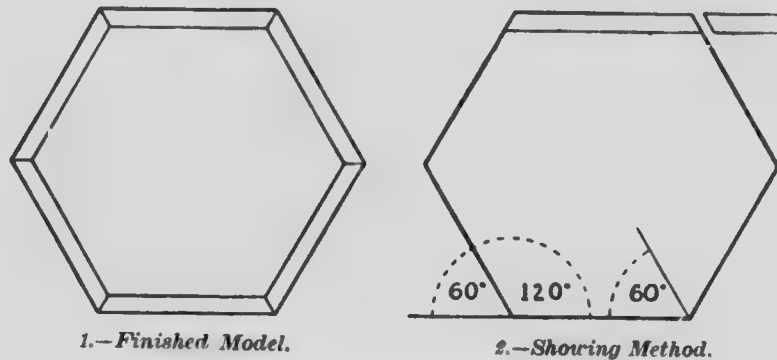
The square being cut out neatly and accurately, the operation of binding may be next tried. Two methods are available—one to supply the pupils with strips cut to the proper size, viz., half an inch wide; the other, to allow each pupil to cut for himself a strip off a wider piece. For a small number of pupils, the latter is the better way; but for large classes the half inch strips are to be preferred. The pupils should be asked to calculate the length required, a trifle over the exact length being allowed for waste. The next operation is to fold the strip carefully down the centre, and this will be found to call for some care and patience, and the result should be inspected by the teacher before the creased piece is cut into lengths.

The diagram should make the order of the binding operations fairly clear. The first piece runs right through from side to side. In sticking it on, the finger and thumb of both hands should be employed, and the card pressed well into the angle of the binding. The second piece will require to be "mitred" as shown. In this case, the card being square, the mitre can be marked with a  $45^\circ$  set square, or the mitre may be found by holding the second piece in position and drawing a line from the inside edge to the corner of the card. The third piece is fitted in a similar manner, but the fourth requires considerable care in fitting, as *both* ends are mitred, and the piece of binding has to be cut exactly to length before being stuck on. If prepared binding or bookbinder's cloth be used, the back or plain side should be moistened with a wet sponge before the gummed side is wetted.

## EXERCISE 2. A HEXAGONAL MAT

This is a useful exercise because of the lesson on angles for which it affords an opportunity.

The drawing should be that of the finished model, and the hexagon may be constructed by any of the methods given in the elementary course. As in the square mat, very careful



EX. 2. A HEXAGONAL MAT, WITH BINDING.

measuring of the quarter-inch border, which shows the binding, is necessary. In each case, the mitres can be readily tested, as they are, of course, portions of diagonals of the figures.

The cutting out is not difficult, and the steps of the binding operations are similar to the previous exercise. It will be found, though, that the mitre on the second piece is formed by cutting off the first piece along the edge of the card, as shown in the diagram, and so on until the sixth and last mitre is reached. This will have to be marked and fitted in a similar way to the last piece of Ex. 1.

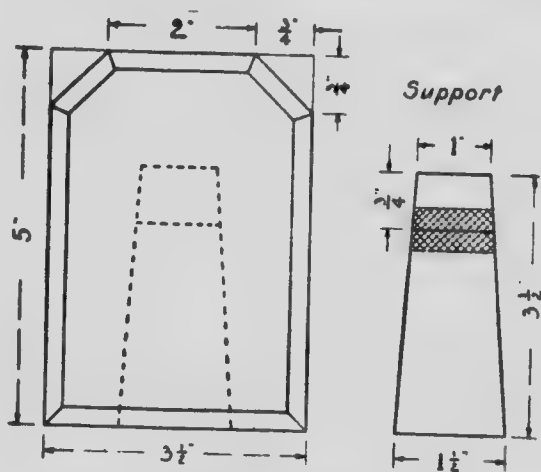
The reason for the process should be seen by the pupils, and a blackboard sketch, such as shown in the diagram, aided

by a recapitulation of some of the earlier talks on angles, should make it clear.

### EXERCISE 3. A MENU CARD OR PHOTO EASEL.

This model introduces a little more difficult binding, and the drawing will also make more demands on the pupils' care and attention.

In the diagram, the leg, or support, is shown at the side of the model, and its position is indicated in the main drawing by dotted lines. Commence the drawing by making an oblong



EX. 3. A MENU TABLET OR EASEL.

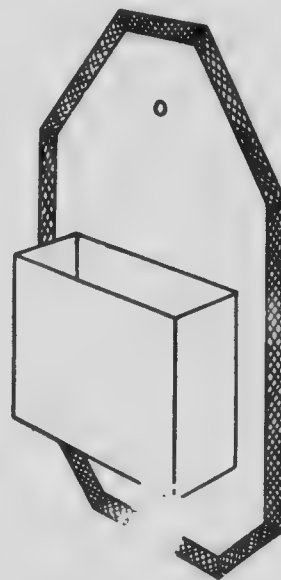
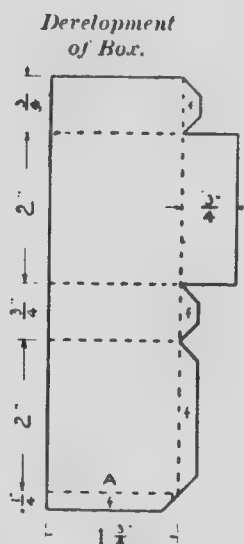
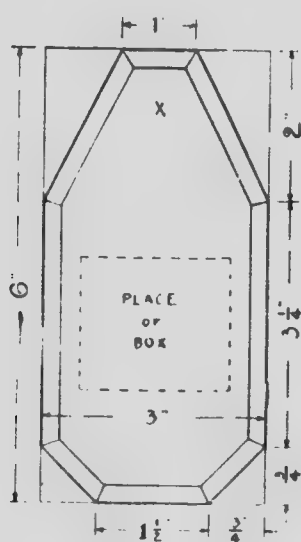
5, by  $3\frac{1}{2}$  inches, and mark off  $\frac{3}{4}$  of an inch from the upper corners, as shown. Complete the outline and then draw the binding. Next, the support should be drawn at the side of the main drawing. Commence by erecting a vertical centre line, and across that make lines at right angles at the given heights. By measuring off half the given dimensions on either side of the centre the correct shape is obtained. This is a practical application of fractions, and as such, should be useful. After cutting out the support, a strip of binding should be pasted across the two halves, as shown in the diagram, to form a hinge. In fixing the support to the front portion, a tiny drop of liquid glue, scraped carefully over the

surface of the small half of the support, will be found more effective than paste. The cloth hinge should be underneath, next to the front portion.

As in the pasting in the elementary course, a wooden toothpick, or a strip of card, will be found to make the best "brush" for glueing.

#### EXERCISE 4. A HANGING MATCH-HOLDER

This makes an interesting model and brings in the "development" or unfolding of a portion of it in the



EX. 4. A HANGING MATCH-HOLDER.

A MATCH-HOLDER.

*Perspective View.*

drawing. Drawings of the back and the development of the box portion, as shown in the diagram, should be made by the pupils.



Commence by drawing an oblong six by three inches, and measure off the corners as shown. Draw the outline and binding lines, and then indicate the position of the small box by dotted lines, as in diagram.

For the second portion of the drawing, the teacher should have a piece cut out, ready to fold up, to show the pupils how the box is formed. Of course, the finished model will already have been inspected by them. The drawing is not difficult, and the dimensions are simple ones. The little pieces marked *ffff* are known as glue flaps, and are always a quarter of an inch in width. It should be noted that the corners are cut off each flap at  $45^\circ$ . This is to allow of their turning up inside the model, these little flaps being the means by which the model is held together, a thin film of glue being spread upon them for that purpose.

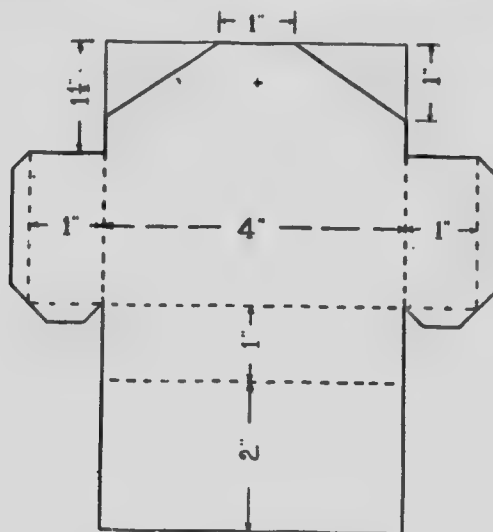
The practical work of the back requires no explanation, being only slightly more difficult than the previous models. The cutting out of the box, however, involves a new operation, viz., "half-cutting." The dotted lines in the development indicate that the cardboard is to be cut only half way through to allow of its being bent neatly and evenly. It will be found that some mistakes will be made at first—either of cutting too far through, or of not going deep enough. After making a half-cut line, the card must be bent *away* from the cut. Great accuracy is needed in the drawing on the cardboard, or the corners of the box will not meet when folded. After the development is ready for folding, the flap at *A* should be lightly glued and brought into position behind the large piece at the other end. Hold it between the finger and thumb of either hand, the second finger being pressed inside the box.

It will set in a minute or so, and the three remaining flaps can then be glued and the bottom pressed down in position on them. When quite set, the box is glued into position on the back, and the model is complete.

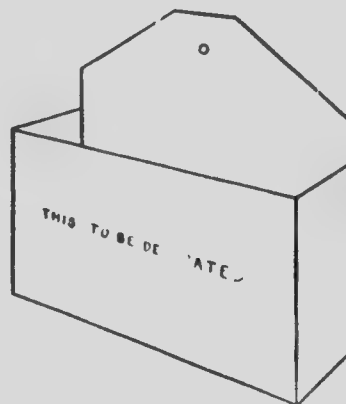
The position of the hole in the back for hanging the model by is indicated by the small cross formed by producing the mitre lines until they intersect. As before, a ticket-punch is used for making the hole.

#### EXERCISE 5. A SMALL WALL POCKET FOR POST CARDS, ETC.

The drawing should be the development as shown in the diagram. As before, the teacher should have two models



EX. 5. A WALL POCKET.



THE FINISHED MODEL.

for teaching this exercise; one finished, the other unfolded, showing the development, and capable of being folded up in demonstration before the pupils.

For the drawing, it is best to construct first the oblong, which is to be folded to form the back, bottom and front. The side pieces, with their small glue flaps, should then be drawn. No binding is used on this model, so the drawing is simplified in that respect.

The practical work is not difficult, but the measuring must be exact, and the half-cutting very even, or ugly angles will result. Care must be taken in glueing the flaps to have the smallest possible amount of glue, or poor joints and "messy" work will result. Scrape it on with a slip of stiff card, or a wooden toothpick, so that no superfluous liquid will be squeezed out when the flaps are pressed together.

During the early attempts at "half-cutting," the angles are often very uneven when folded, from the cut being a trifle deeper in some places than in others. The best way to remedy this is to recommend a steady but lightly pressed stroke with the knife right along the cut. Short, partial cuts are never successful, but with a firm, bold stroke *and practice*, the half-cutting and subsequent folding is quite simple.

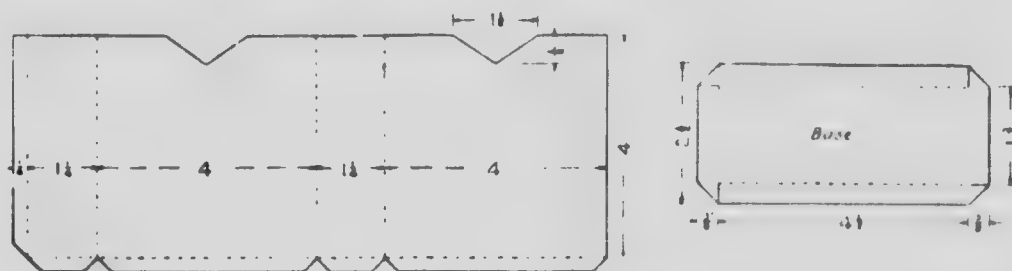
These exercises may be of fancy or plain cardboard. If the latter be used, the models should be decorated with designs in coloured paper, crayons or water-colours.

#### EXERCISE 6. AN ENVELOPE CASE

This model is in two parts, and the development of each should be drawn.

In the practical work the upper portion calls for no particular mention, as it is similar in principle to the previous

exercises. Some care will be needed in cutting out the triangular pieces, and the pupils must be warned against cutting

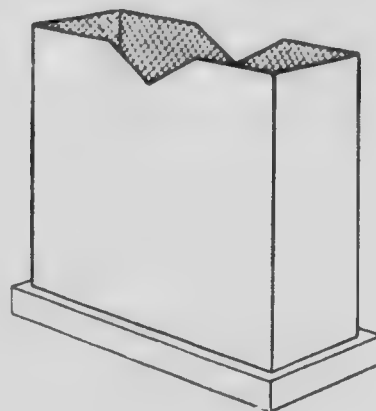


EX. 6. AN ENVELOPE CASE

too far. The best way is to press the point of the knife firmly into the cardboard at the inner angle and then to cut outwards to the edge.

The base illustrates another method of joining angles, the glue flaps being triangular pieces. In making the base, first cut out an oblong  $5\frac{1}{4}$  by  $2\frac{1}{2}$  inches. Then mark off the side pieces and carefully "half-cut" right along each line. The corners can then be cut off and the triangular pieces severed along one edge, so that they may be turned up underneath and glued to support the sides.

Glue the base up first, and while that is setting the upper portion can be folded and glued on the long flap. When this joint is set, glue the four remaining flaps and press into position on the base.



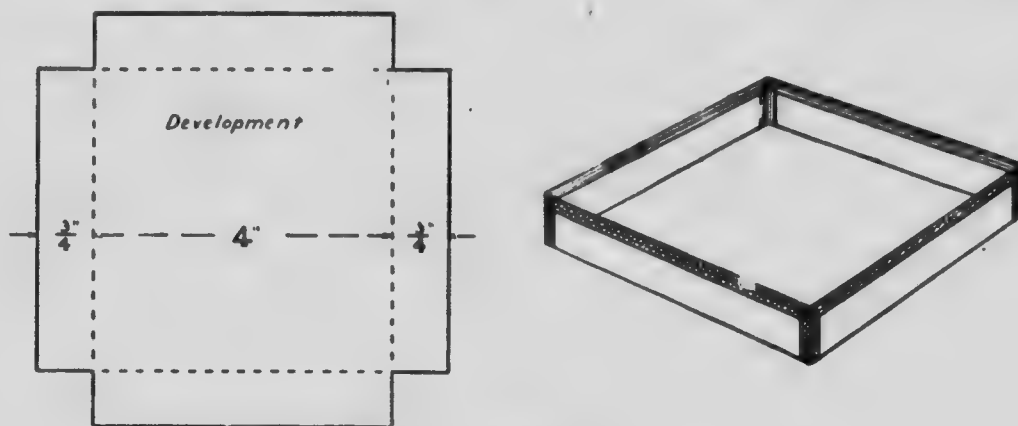
EX. 6. PERSPECTIVE VIEW.

An agreeable effect may be obtained by making the base of different coloured card from the upper portion.

### EXERCISE 7. A SQUARE PIN TRAY

This is similar in some respects to the square tray of the elementary series, but instead of the angles being tied with cord or ribbon, they are bound with a strip of gummed cloth.

The drawing will be the development as shown. For the practical work, mark and half-cut as in the base of the previous exercise, but cut the corner bits right out in this



EX. 7. A SQUARE TRAY.

case. Then take a short piece of prepared binding and crease it carefully through the centre. Fold up two sides of the tray until they meet, moisten the strip of binding and press it firmly on the outside of the angle. Great care must be taken to get the binding quite even; that being one of the things which make or mar this model. The tendency is to get it a little out of centre, or slightly askew, thus spoiling the lines of the article.

Cut the binding off about one-sixteenth of an inch above the top edge of the tray and press it down over the edge into the angle. Finish the rest of the corners in this way, and then crease some binding with the gummed side out, and cut off four short pieces for the inside of the angles. Moisten and press them well into position with the edge of the ruler, making the tray strong and neat thereby.

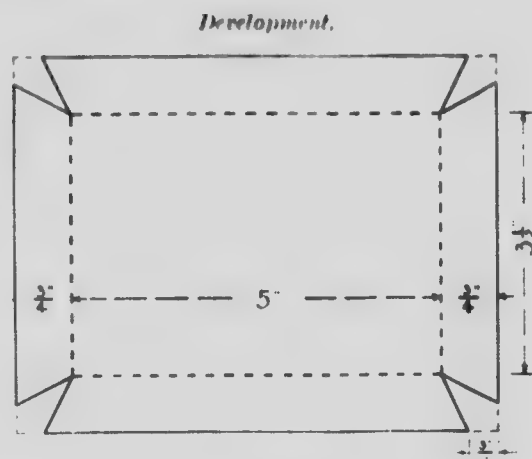
The upper edges should now be bound, and the simplest way is to cut the binding into the exact lengths of the sides, crease each piece through the middle, and bind one edge at a time. It is possible to keep the binding in one length, but the writer has always obtained better results by cutting it up, as each corner can then be neatly mitred. Stout cardboard, 8-ply in thickness, should be used for this and the succeeding model.

#### EXERCISE 8. A TRINKET TRAY

The general principles of this model are similar to those of Ex. 7, but the sides are sloping instead of upright.

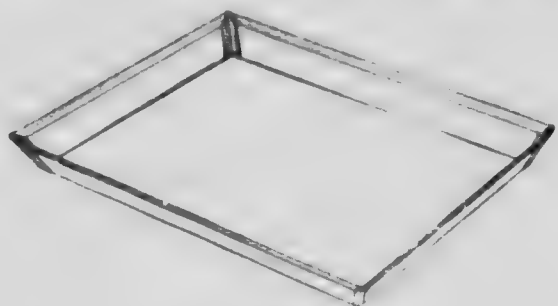
Proceed exactly as in Ex. 7 in drawing and cutting out the cardboard; also in the order of the binding operations. The difficulties in this model

arise from the fact that the ends of the binding are not square, but have to be carefully



EX. 8. A TRINKET TRAY.

fitted in each corner. The half-cutting has also to be stopped when it reaches the right angle.



*Ex. 8. Perspective View.*

Cardboard tinted on one side looks well in these trays. Draw and half-cut on the plain face and thus bring the tinted face inside the tray.

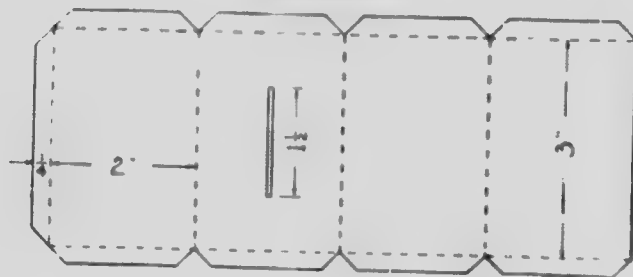
These trays are excellent objects for decoration as suggested earlier in the chapter.

#### EXERCISE 9. A MONEY BOX

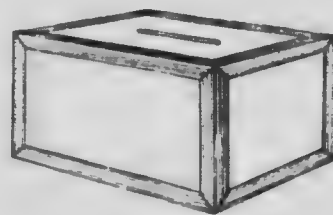
Another exercise in development, and a model usually very attractive to the pupils.

After showing the children the finished model, and eliciting the number, shape, etc., of the surfaces, the development

*Development.*



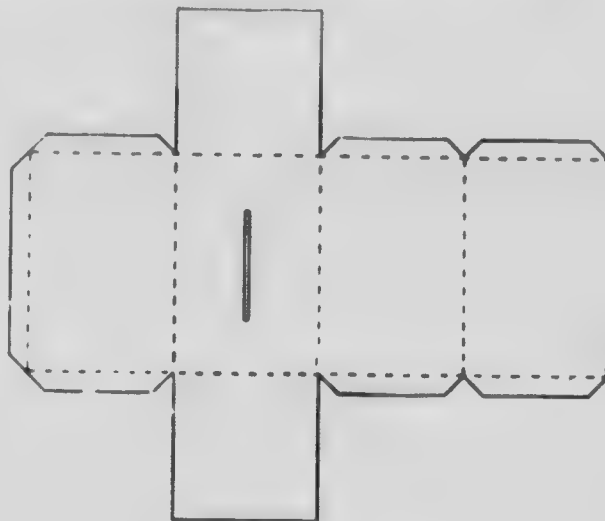
EX. 9. A MONEY BOX.



*Ex. 9. Perspective View.*

of the four long faces should be drawn. On one of these the slit for the coins must be shown.

For the practical work, little explanation is required. Draw and cut out, as shown in development, taking care to get the half-cutting of even depth. The slit for the coins is formed by punching holes at either end of it, and cutting from hole to hole with the point of the knife. This portion may then be glued and left to set while the ends are being prepared. Cut out two pieces exactly square, glue the flaps of the long portion and press the ends into position on them.



*Fig. 9. Alternative Method.*

Binding the angles of this model considerably improves its appearance, but may be omitted if desired.

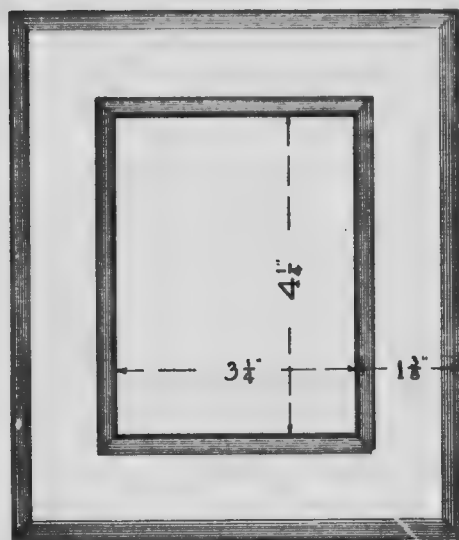
An alternative method of making is shown in the diagram. It is a better way, but as it involves considerable waste of material, is not recommended where expense is a consideration.

#### EXERCISE 10. A CABINET PHOTO FRAME

Draw as shown in diagram. If it is desired that the frame be made to stand on a table, a leg must be formed similar to the support of the menu card, and this will, of course, require a drawing.



In cutting out, a new operation is involved in forming the opening for the picture. Each cut must commence right in the angle. Particular attention must be paid to this, and good clean corners demanded.



EX. 10. A CABINET PHOTO FRAME.

In binding the outside edges, nothing new is introduced. The edges of the opening will, however, demand very careful work. There is no overlapping, and each piece must be mitred exactly to meet the next one.

After the front portion is complete, glue a plain piece of card along three of its edges and press it into position on the back.

If the frame is to hang, punch a couple of holes and insert some fancy cord, or narrow ribbon, to suspend it.

#### EXERCISE 11. AN OXFORD PHOTO FRAME

This is a variation of the last design, and is somewhat more difficult to cut out, owing to the number of internal angles in it.

The drawing is fairly simple, and the practical work needs no explanation.

Owing to the great number of mitres necessary, this frame takes a somewhat long time to bind. It is not abso-

lutely imperative to bind it, however, as it looks very well without it.

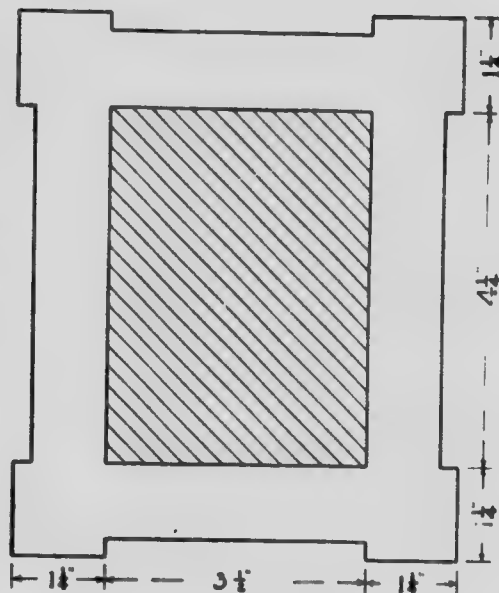
As in Ex. 10, it can be made to stand or hang up, and either of the frames can, of course, be used for an upright or lengthwise picture.

#### EXERCISE 12. A NEEDLE CASE

This and the following exercise are alike in principle, and the pupils need not be required to do both of them. In practice, the writer has found it a good plan to give the girls No. 12, and the boys No. 13. This involves a little more trouble on the part of the teacher, but the added interest arising from such differentiation will repay this.

The drawing is simple, but care is needed in spacing the pieces at the proper distance apart; therefore careful drawing and dimensioning must be insisted on.

For the practical work some stout cardboard, a piece of "marbled" paper as used by bookbinders, and some binders' cloth are needed. Cut out two pieces of card for the covers  $2\frac{1}{2}$  by  $3\frac{1}{2}$  inches, and then a strip of cloth  $1\frac{1}{2}$  inches wide and  $7\frac{1}{2}$  inches long. If gummed cloth is used it may be moistened ready for sticking on, but paste is rather better than mucilage in this case. When pasted or gummed, lay the strip flat on



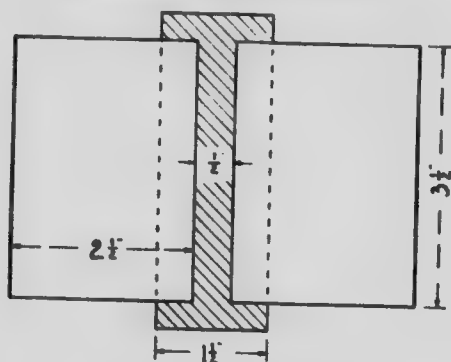
EX. 11. AN OXFORD FRAME.



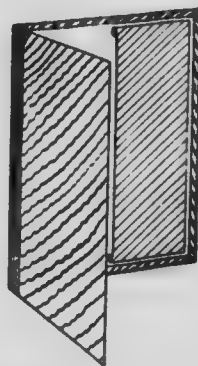
CARDBOARD CONSTRUCTION AND ELEMENTARY BOOKBINDING.

the desk and place one piece of card in position on it. A line should be drawn on the card to guide in laying it down on the cloth. The other piece of card can then be laid in place and pressed well down on the cloth. Now turn up the ends and fold them over the face of the card and press all surfaces well together. The laps should come inside the covers when finished.

*First Stage. Binding the Back.*



EX. 12. A NEEDLE CASE.



*Perspective View.*

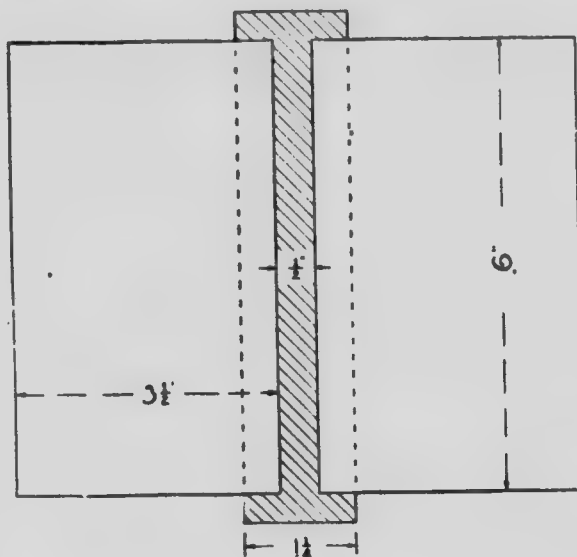
The marbled paper can now be applied. Cut out two pieces 4 by  $2\frac{1}{2}$  inches and paste the plain side. In laying them on the covers care must be taken to leave an even margin of cloth down the back. Fold the edges over carefully and press them well down inside the covers. Two plain pieces of paper,  $\frac{1}{4}$  inch less each way than the card, should be pasted on the inside to make a neat finish and to cover the edges of the marbled paper.

The small pockets to hold the packets of needles are formed by pasting a strip of cloth on each cover. Cut out two strips  $3\frac{3}{4}$  inches long and  $1\frac{1}{2}$  inches wide, and turn in a quarter

inch hem all round. Paste three of the turns and press into place with the open side towards the back of the covers.

Repeat on opposite cover and the model is complete.

If desired, a small piece of flannel can be folded and pasted in by a narrow line of paste down the back. This will serve to hold loose needles, etc.



EX. 13. A POCKET BOOK.

### EXERCISE 13. A POCKET BOOK

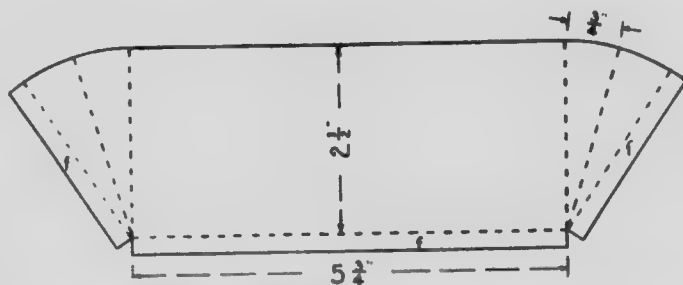
Very little explanation of this model is

required, as the operations are almost exactly as in No. 12.

In the case of the pocket, however, a little different creasing is necessary if it is to hold anything.

The diagram makes clear the method of cutting and creasing, and after the teacher has made the

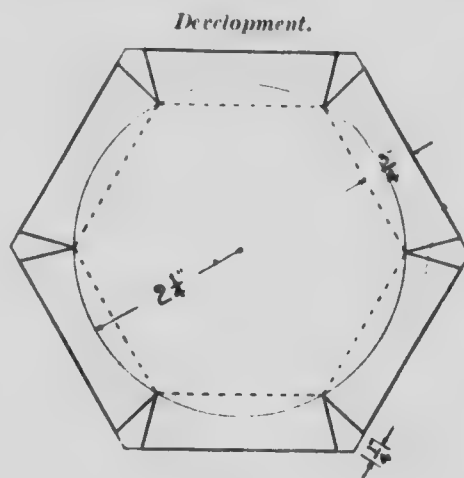
model, no difficulty will be experienced in teaching the folding of the cloth so as to allow the pocket to open a little.



EX. 13. Method of Cutting and Folding the Cloth for Pocket.

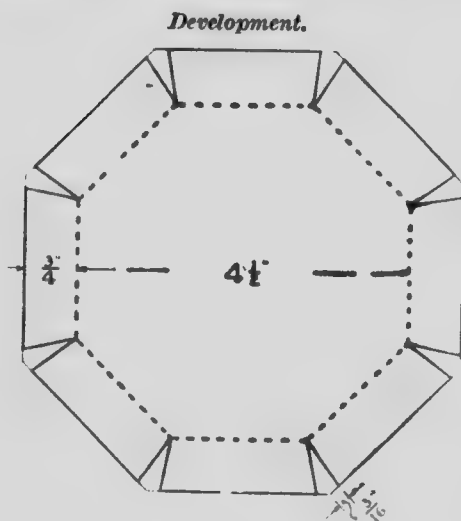
### EXERCISE 14. A HEXAGONAL TRAY

As in the square tray, the model can be made by tying, instead of pasting, the corners. The latter method makes a neater article and gives a better training in manipulation for the children. Draw as shown in the diagram, taking care to make the outer hexagon perfectly parallel to the inner figure.



EX. 14. A HEXAGONAL TRAY

For the practical work, draw the figures on the under side of the card. The half-cutting requires great care, as the cuts have to be stopped at each angle, or the sides of the tray will be spoiled.



EX. 15. AN OCTAGONAL TRAY.

In binding, it is best to follow the order as given for the square tray. First, the outer angles, then the inner; and last of all the upper edges.

If plain card is used, the hexagon is an admirable figure on which to draw or paint a simple design. A hexagonal or octagonal tray decorated with brush drawing or crayon design, looks exceedingly well.

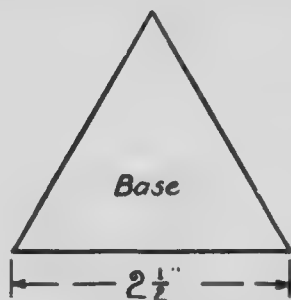
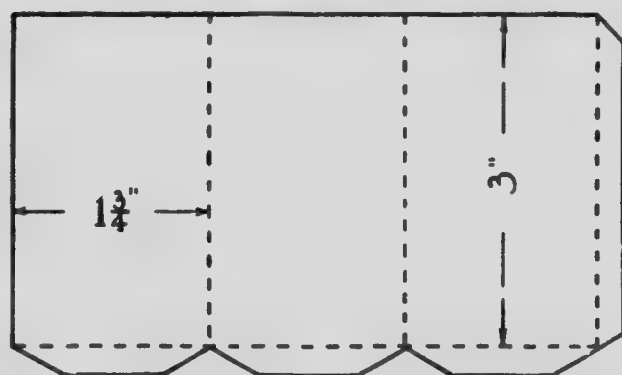
## EXERCISE 15. AN OCTAGONAL TRAY

This model presents no new features, beyond the difference of the geometrical figure, from the last one.

In the drawing and practical work, precisely the same steps are followed as in Ex. 14, and therefore no further instructions are necessary.

## EXERCISE 16. A TRIANGULAR TAPER POT

This model helps to give the idea of volume and, incidentally, adds to the child's knowledge of the simpler solids. The

*Development.*

EX. 16. A TRIANGULAR TAPER POT.

*Perspective View.*

building up of a prism from three rectangular surfaces is involved, and the drawing will therefore be the development of the prism.

Draw as in diagram and proceed to cut out two pieces of card—one for the base and one to fold and form the prism.

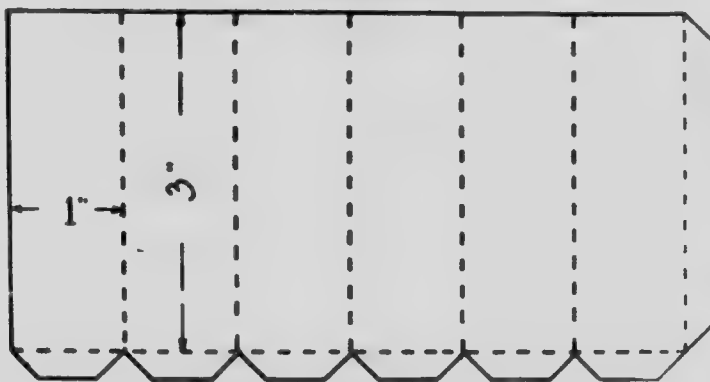
After half-cutting, glue up the prism on the long edge and bind each angle. Then bind the upper edges and it is ready to glue in position on the base.

The base should be prepared by binding the edges so that the prismatic portion just covers the edge of the binding when glued in position.

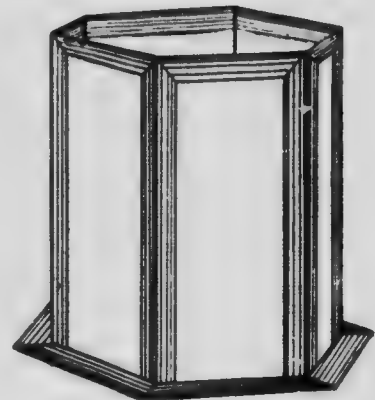
Care must be taken in affixing the base to keep the margin even and the prism quite central.

### EXERCISE 17. A HEXAGONAL TAPER POT

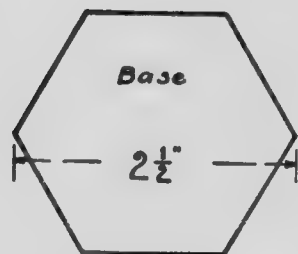
*Development.*



EX. 17. A HEXAGONAL TAPER POT.



*Perspective View.*



The remarks and instructions for Ex. 16 apply to this model also, and but little explanation is required.

One point, however, will require some care. The triangular prism is, of course, bound to retain its shape when glued up ready for fixing to the base. The hexagon will assume all sorts of shapes, however, and great care is

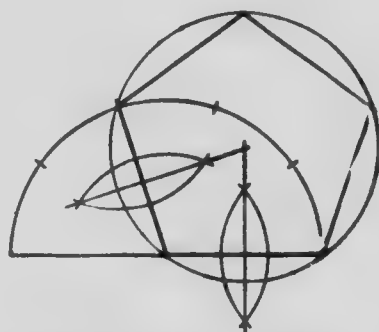
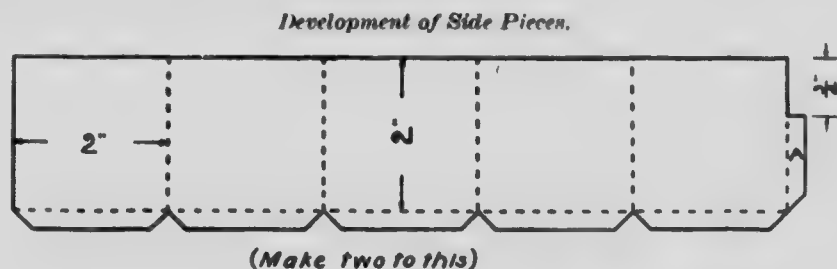


necessary, in glueing the base on, to keep the hexagon regular in shape.

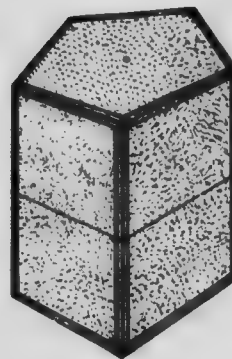
The binding may be omitted in Exs. 16 and 17, but the models will not look nearly as well.

### EXERCISE 18. A TWINE BOX

This model serves as an introduction to the pentagon and also introduces a common method suitable for constructing cardboard boxes with movable covers.



*Method of Drawing Pentagon.*



*Perspective View.*

EX. 18. A PENTAGONAL TWINE BOX.

The method of drawing the pentagon, shown in the diagram, was given in an earlier exercise on the octagon. It depends upon the fact that the sum of the exterior angles of

any polygon is equal to four right angles. At this stage of the work, with the pupils' experience of plane figures, and their knowledge of angles gained from earlier exercises, the teacher should be able to deduce this rule quite easily. Then by describing a semicircle on a given base and dividing it into the same number of equal parts that the polygon has sides, *two* of the divisions will always give the exterior angle.

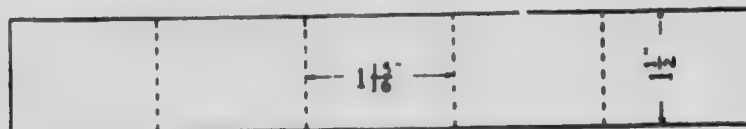
This method depends upon the division of the semicircle by trial, and is therefore only an approximate one. If ordinary care be taken, however, the result will be exact enough for almost any purpose. In addition to the pentagon for the top and bottom, a drawing should be made of the development of the sides. One drawing will suffice, as the upper and lower portions are exactly alike.

The practical work should be commenced by cutting out two pieces, as shown in the development, and glueing them upon the edges A. The two pentagonal pieces for the top and bottom should then be cut out and glued into position. Nothing new is involved in this and no difficulty should be experienced if the measurements have been carefully made. Next cut out a strip  $1\frac{1}{2}$  inches wide and half-cut it so that it will fit exactly inside the lower half of the box. A sketch of this piece is given, and it must be noted that each division is one-sixteenth of an inch less than the width of the sides of the box. This piece should then be glued into position, so as to stand up three-quarters of an inch above the lower portion of the box; when it will fit into the upper portion and hold it in place.

For finishing the outside of this model, a new method is suggested. That is, to bind the corners first and afterwards to

cover each face with a piece of fancy paper cut small enough to show a very narrow margin of binding all round its edges. This gives an exceedingly neat finish and also allows of the use of common cardboard for the model.

In putting on the binding and fancy paper the box should have the cover on. After the binding and fancy paper are quite dry, a sharp knife should be used to cut through the paper and separate the two portions of the box.



EX. 18. PIECE FOR INSIDE OF BOX.

Of course a hole will be required in the centre of the top through which the twine may be drawn out.

It may be well, also, to remind teachers that a ball of twine should be used from the *inside* of the ball, where a loose end may always be found. Neglect of this will cause loss of time, twine and temper from commencing to use a ball of twine from the outside.

#### EXERCISE 19. A SLIDING PENCIL BOX

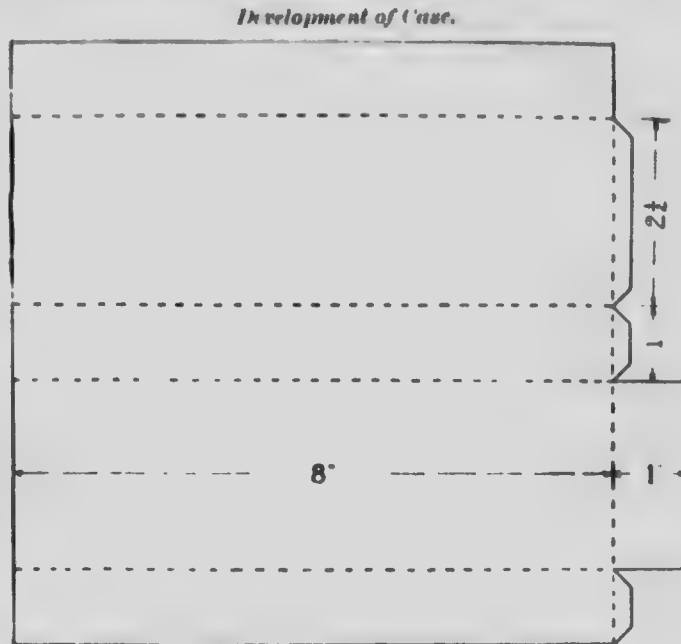
This model calls for very careful work, as the inner portion must slide easily, and yet fit neatly, within the outer case.

Two drawings are required, and it will be noted that the dimensions of the drawer piece are one-eighth of an inch smaller each way. As the drawings are rather large, they may well be made to scale, say, half size. Note that the glue flap is the full width of the side pieces. In glueing up this

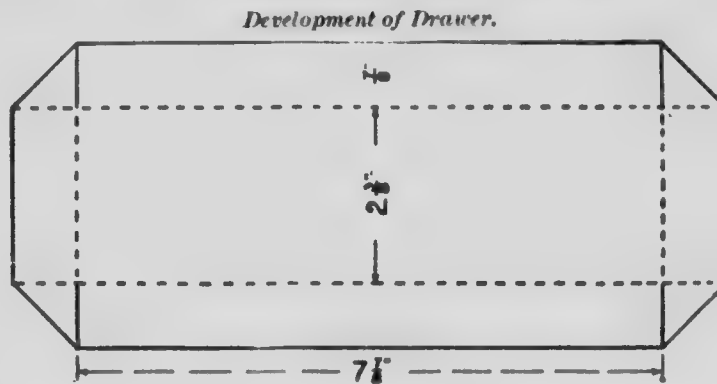
flap it is not possible to reach into the inside of the box to press the surfaces well together. This can best be managed by putting the ruler through and pressing the surfaces together on the desk with it.

The drawer will present no difficulty if the diagram be carefully followed.

The outside of the box may be finished in one of several ways. If fancy card be used, the model will look

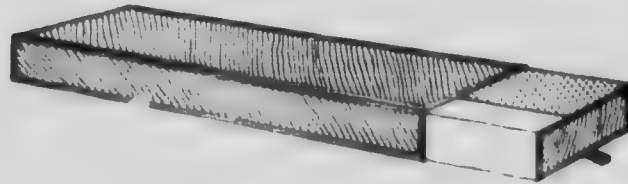


EX. 19. A SLIDING PENCIL BOX.



fairly well without any other finish. The method suggested

for the pentagonal box is, however, by far the neatest method of finishing this and similar models. First bind the edges with some dark-coloured binding—paper will do—and then



*Ex. 19. Perspective View.*

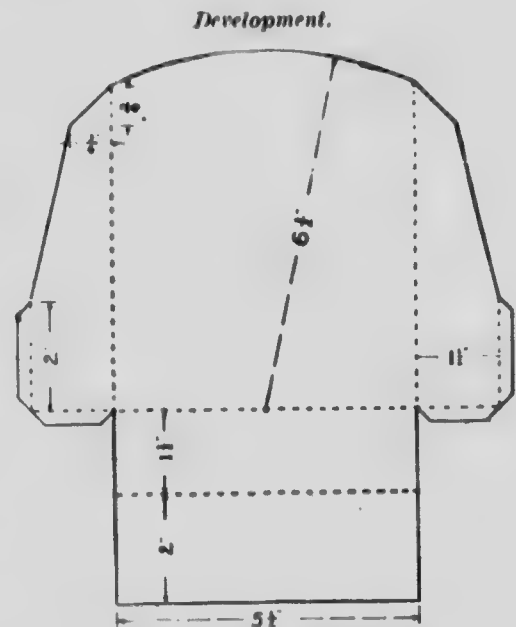
cut some fancy paper so as to show a margin of coloured binding one-eighth of an inch in width.

A small piece of tape glued on the under side of the drawer so as to stand out about half an inch, will serve to pull the drawer out by.

#### EXERCISE 20. A STATIONERY CASE

This model is usually a favourite with children, but takes a rather large piece of stout cardboard for its construction.

The development of the body of the model should be drawn as in the diagram. A drawing must also be made of the division, a separate piece being glued in afterwards to form this. A separate piece is also required for the base, but a drawing of it is scarcely necessary.

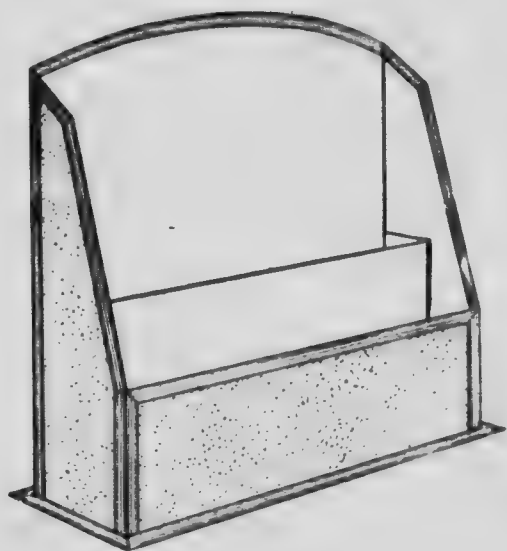


EX. 20. A STATIONERY CASE.

The cutting out and glueing up should present but little difficulty. It is well, though, before glueing up, to decide on the manner of finishing.

This model looks very well if left white inside and covered with fancy paper outside. The fancy paper can be pasted on before the model is glued up, but the binding of

the edges and angles must be done afterwards. The binding of the curved edge will require a little ingenuity. Moisten the binding thoroughly on the plain side as well as on

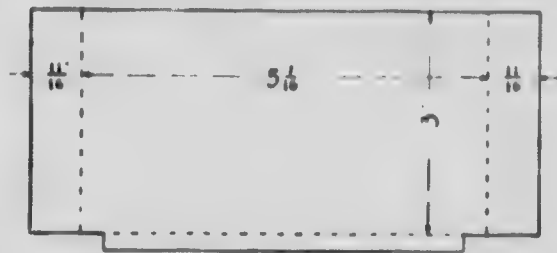


*Perspective View.*

the gummed, and stretch it round the curve between the fingers and thumbs. The same difficulty will occur in the curved back of the next model.

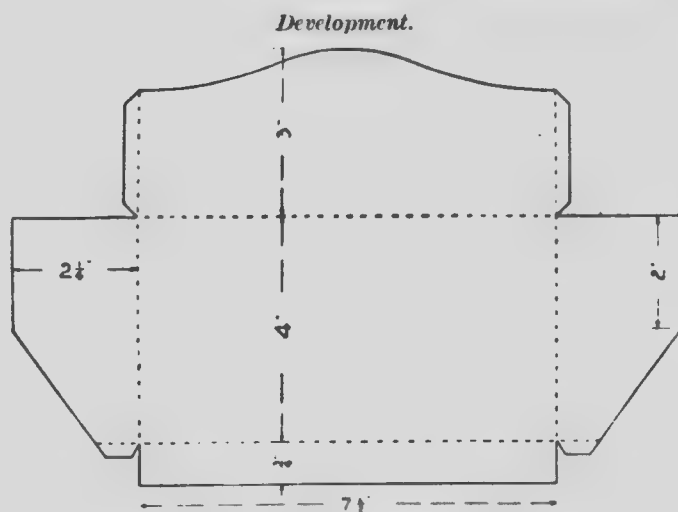
After binding, slip the division into position, taking care to have very little glue on the flaps.

Next cut a rectangular piece half an inch larger each way than the bottom of the body, bind its edges, and glue into position to



*Ex. 20. Division Piece.*

## EXERCISE 21. A PEN-AND-INK TRAY



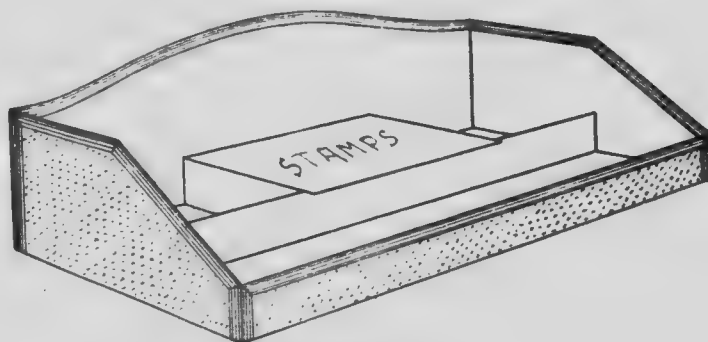
EX. 21. A PEN-AND-INK TRAY.

This model is not very difficult but requires care in cutting out and fitting the divisions.

The drawings should be those given in the diagrams.

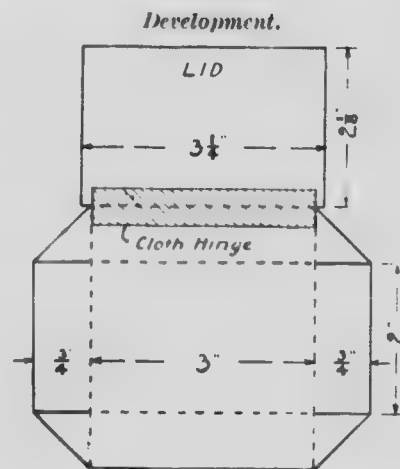
The order of the practical work is the same as in

the stationery case, and little difficulty should be experienced if the instructions are followed.

*Perspective View.*

The development of a small box is shown. This box should be made and glued into position as shown in the perspective view. A strip should then be fitted against the front

of it and glued into position. This strip is not shown in the developments of this exercise, but its size is easily obtained. It will require a small glue flap at either end and must also be glued to the front of the stamp box. The small square corners enclosed by this strip are for ink bottles.



EX. 21. STAMP BOX TO BE FIXED IN TRAY.

### PORTFOLIOS

To make this stage of the course more complete, a couple of portfolios have been included. The making of them is slightly more difficult than the preceding models on account of the larger surfaces to be covered; also the problem of binding the backs so as to open properly.

Such portfolios are very useful for holding loose sheets of drawings, nature notes, etc. Their making involves, in the first place, a discussion of the standard sizes of paper. This will lead up to the fact that all books are of such a size that their leaves may be cut from a large standard sheet without waste, and to an understanding of the terms "quarto," "octavo," etc. (Any good dictionary gives the standard sizes adopted by paper makers.)

Having the sizes of the drawings, etc., for which the portfolios are to be made, the next step is to decide on the size of the covers. This is conditioned by two considerations: first, the proper margin to be allowed over the sizes of



the sheets of paper, and, second, the standard sizes in which cardboard or pasteboard, the base of portfolio construction, can be obtained.

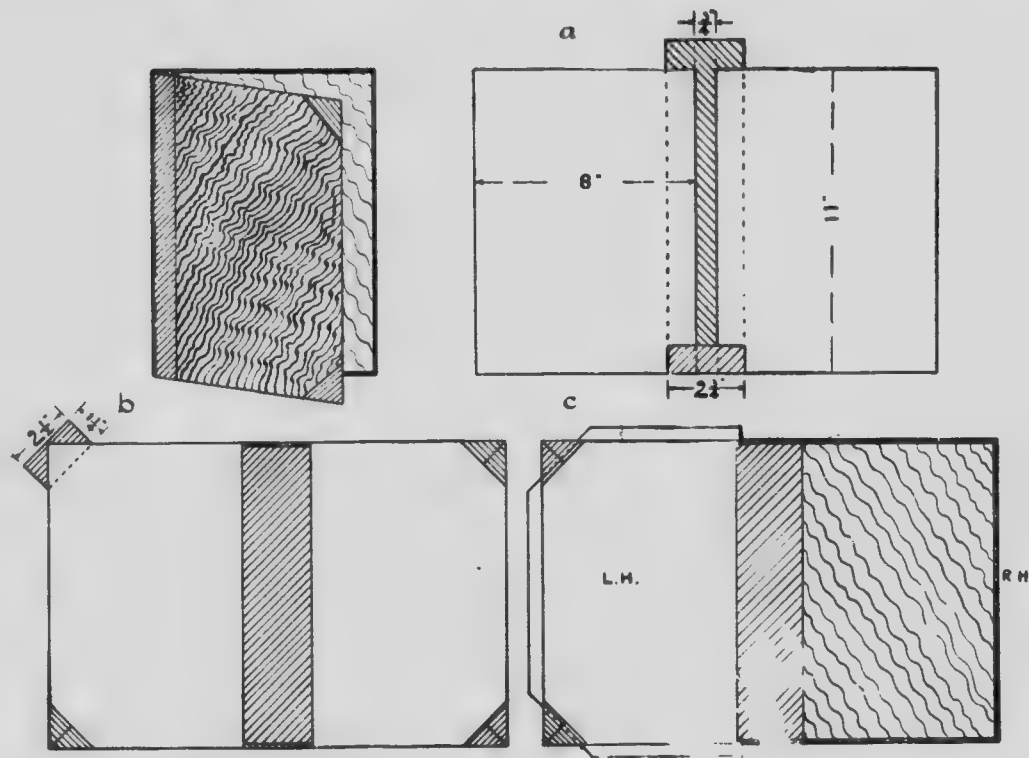


FIG. 22. A PORTFOLIO AND ITS CONSTRUCTION.

Fig. 22 shows a portfolio with a hinged back, and is planned to take small drawing sheets  $7\frac{1}{2}$  by 10 inches (cut from "crown" standard sheets without waste).

Fig. 22, *a*, *b*, and *c*, show the several steps in the work; also the sizes of the covers, which give a margin of half an inch at top, bottom and front edges, over the size of the sheets to be kept in the portfolio. Heavy pasteboard can be obtained in sheets of 22 by 36 inches, which will cut the portfolio covers

without much waste. A low grade white "printer's board" of 10-ply in thickness, is the most satisfactory for this work.

For the backs and corners, bookbinder's cloth should be purchased by the yard or roll, and cut into suitable widths. The outside of the portfolios may be covered with marbled paper or one of the many embossed papers now to be obtained for the purpose.

For the inside, a great variety of lining papers are available; very tasteful patterns in mauves and grays being easily obtained.

For adhesive material, common flour paste, with a pinch or two of powdered alum to every quart, is the best. It is easily made, as described before, but must be fairly stiff, not sloppy.

The order of work is :

1. Cut the pasteboard to size with the cardboard knife.
2. Cut strips of binding cloth into required widths. For large classes these should be prepared beforehand by pupils appointed for the purpose.
3. Prepare broad strip of cloth by marking with a pencil line the space to be left between the two pieces of pasteboard. The strip must then be

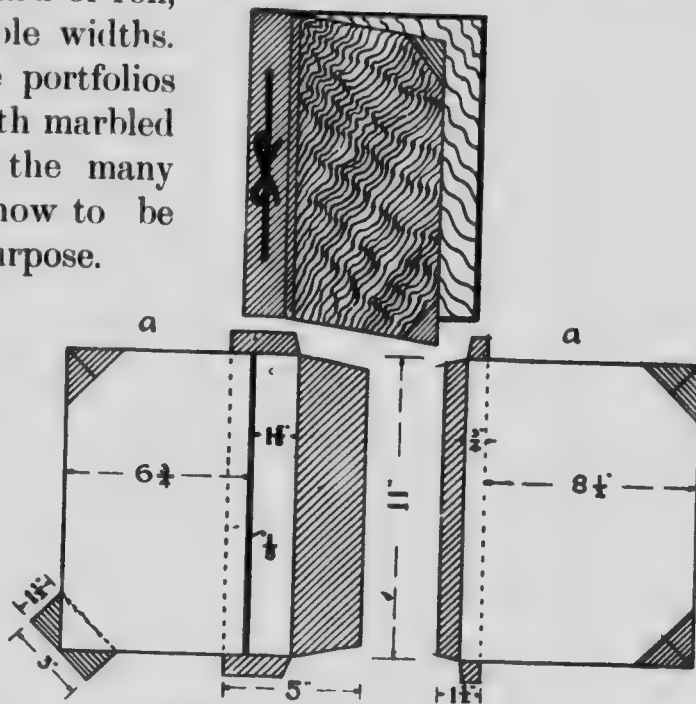


FIG. 23. A LOOSE LEAF PORTFOLIO.

well pasted, laid on the desk, and the covers laid upon it. (See Fig. 22 *a*.) The overlaps at ends (one inch) are then lifted up and pressed over on the inside (see bottom of Fig. 22 *a*). Another broad strip of cloth, one-quarter inch less than the length of covers, is then pasted on the inside, thus completing the hinge and back. (See Fig. 22 *b*.)

4. Cut cloth for corners; paste and attach as in Fig. 22 *b*.

5. Cut out marbled paper (see Fig. 22 *c* (L. H.)); paste well; lay cover down upon it; lift up overlaps and press well down on inside; turn cover over and smooth out any creases or air bubbles; repeat for other half of cover.

6. Cut out lining paper; paste it well; lay it in position and smooth down. As thin paper stretches considerably when pasted, the lining paper should be cut three-eighths of an inch less than the length of the covers.

The portfolio should then be placed on end, with the covers well apart, until dry.

Fig. 23 shows another useful portfolio, adapted for holding the "loose-leaf" or detached sheets now so generally used for science notes. The diagrams, Fig. 23 *aa*, make the construction clear, the order of work being practically as in the portfolio already described.

To make the holes, a small saddler's punch ( $\frac{1}{4}$  in.), costing about 15 cents, will be required. It is operated by a smart tap with a hammer, the covers being held upon a block of hard wood as a support. Better still is a lawyer's eyelet punch, by means of which a brass eyelet can be fixed in each hole. The punching of the holes should be left to the last. A piece of fancy cord or a silk bootlace serves to hold the leaves and covers together.

NOTE. No separate work in colour has been suggested for this stage, but the decoration of many of the articles made in the course will form useful and interesting exercises in designing with coloured papers and other mediums.

## CHAPTER VII

### GEOMETRICAL SOLIDS

AMONG the many subjects of school work in which modern tendencies are changing the methods of instruction, the subject of Geometry has received a large share of attention. The controversy which has raged with varying vigour for the past decade on the merits of Euclidean geometry as a means of training and strengthening the logical powers of the student, seems to have had one effect in calling attention to a phase of the subject which was formerly considered to belong chiefly to the constructive professions, viz., "Descriptive Solid Geometry."

While this subject has been found to be more than ever a necessity for students of engineering, architecture, and their allied sciences, it has also made great progress as a means of general culture of the reasoning faculties.

In Great Britain, the United States, France and Germany it has for many years formed a part of the course in the Science Schools; and the opinion of many careful observers is that its effects as a mental discipline are equally good with the purely theoretical geometry of earlier day. Taken in conjunction with Euclidean geometry, it seems to afford opportunities for applications of many of the abstract principles of that subject, which appeal to students who would otherwise be apt to find in it but little of real interest.

In the study of Descriptive Geometry, cardboard work is distinctly useful. Not only can a series of typical solids be easily constructed, but the various problems involving sections of these solids and the development of their surfaces may be worked out and practically exemplified.

A set of type-forms of solids is also a necessity for the primary teacher. If a right use be made of them, they are a great aid in the development of the sense of form in the children and in enabling them to recognize the various types in simple everyday objects round about them. The type models are also very useful in the drawing, clay modelling and other "occupations" of the elementary school.

In this chapter, directions are given for the construction of such a set at a cost of little more than the time and trouble in making. The same directions serve for the construction of the set on a smaller scale by pupils of the upper and high school grades, as a preliminary and concomitant to the study of theoretical geometry.

A few typical examples of the application of cardboard modelling to the illustration of simple problems in orthogonal or orthographic projection are given in the succeeding chapter; also some practical examples of the working out of some of the difficulties so frequently occurring in problems which involve the development or unfolding of the enveloping surfaces of simple and composite solids.

For tools and appliances, a cardboard knife (see Chap. VI), a brass edged ruler, a couple of set squares, a pair of compasses and a pad of stout millboard (strawboard) to protect the desk top, will complete the list.

For the materials, some 4- or 6-ply white or grey cardboard, of fairly good quality, will be required for the pupils' models. For the teacher's set, 8-ply cardboard will be necessary if large models are to be constructed. Some good liquid glue for fastening the edges of the models together will complete the list of materials for this course.

The cardboard can be obtained from any stationer, or failing that, most printing offices keep a supply of good white boards and will usually spare a few at a reasonable price.

The drawings given are, in almost all cases, the development of the solid. As suggested in the earlier chapters, the pupils may use drawing books and make the drawing in them first, or may work from the accompanying drawings directly on to the cardboard. The former method is to be preferred.

Twelve typical solids are given and in these are included the five known as "regular" solids, viz., the tetrahedron, cube, octahedron, dodecahedron and the icosahedron. These regular solids may all be contained in a sphere; that is to say, the angular points in each are equidistant from a fixed point within, which is therefore the centre of the enveloping spherical surface. Students of trigonometry will not need to be reminded that a certain relation exists between the diameter of a sphere and the length of the edge of any inscribed regular polyhedron. A simple geometrical method by which these relations may be obtained graphically, without recourse to mathematical calculations, is given in the diagram on page 141.

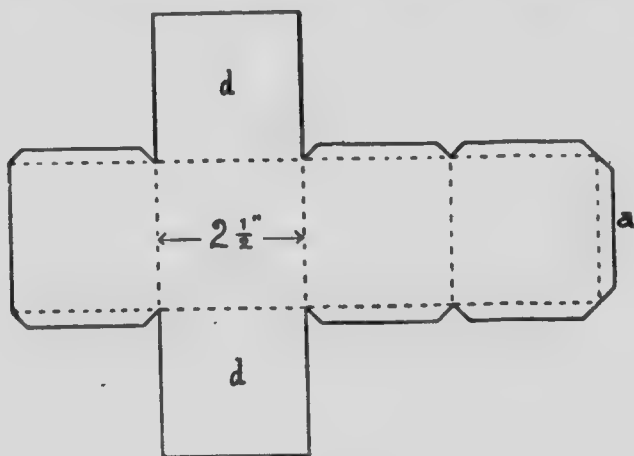
If the models of the earlier chapters have been worked

out, very little instruction in the practical work will now be necessary. The dotted lines indicate that the cardboard is only "half-cut" there, to allow of its being bent with a regular angle.

The small glue flaps should be one-quarter of an inch in width for the pupils' models, but those for the teacher's large set should be correspondingly wider.

### EXERCISE 1. THE CUBE

The drawing shows the best method of making the cube, but uses up a larger piece of cardboard than if the two surfaces *d d* were cut out separately.



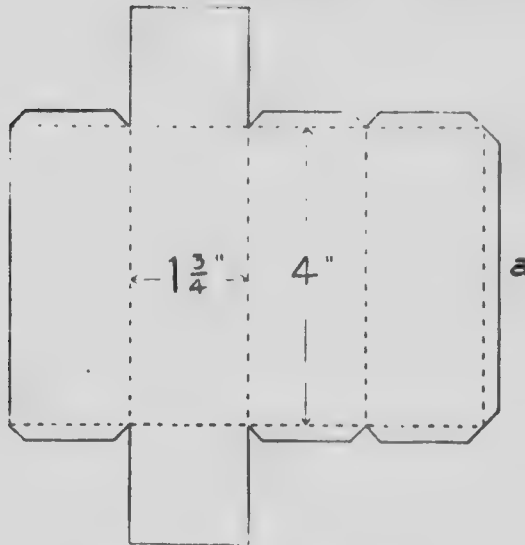
EX. 1. THE CUBE.

In glueing up, use a slip of stiff cardboard for a brush. Scrape a thin film of glue on the flap *a* and fold it into position. Hold the joint for a minute or two until it is well set; then glue the rest of the flaps and

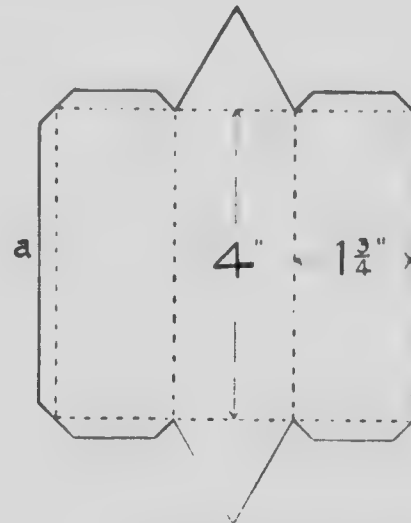
press the surfaces *d d* into position. A book, or other weight, may then be placed on the cube and allowed to remain until the glue is quite dry.

NOTE.—The thicker the cardboard, the more care is necessary in scoring (half-cutting) for bending.

## EXERCISE 2. THE SQUARE PRISM



EX. 2. THE SQUARE PRISM.



EX. 3. THE TRIANGULAR PRISM.

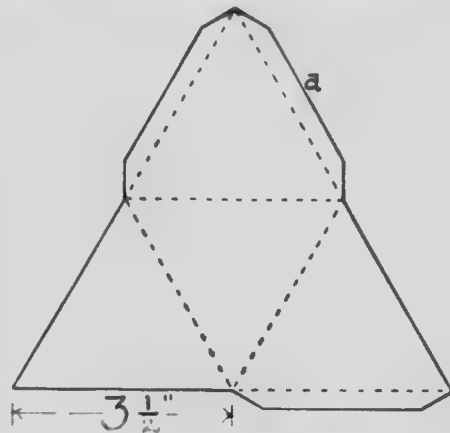
## EXERCISE 3. THE TRIANGULAR PRISM

The construction of these models needs no explanation, the same order of operations being followed as in the cube.

## EXERCISE 4. THE TETRAHEDRON

This solid is quite simple in construction, but accuracy in the drawing must be insisted on if good results are to be obtained.

Glue up on *a* first, and when that joint is set, glue the remaining flaps and press the fourth face against them, holding carefully until the glue is nearly dry.



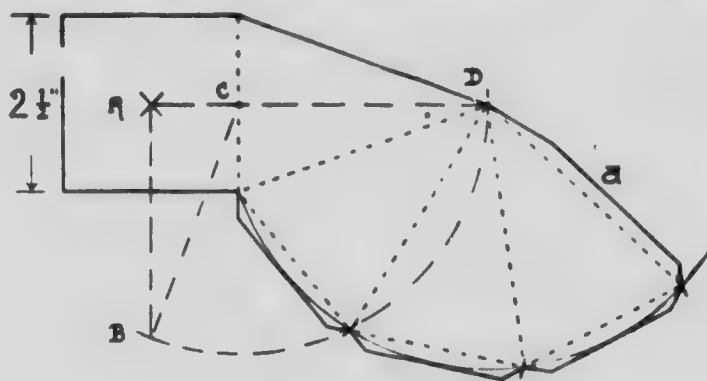
EX. 4. THE TETRAHEDRON.



## EXERCISE 5 THE SQUARE PYRAMID

Another method of developing this solid is sometimes used, but the one shown gives the best results.

The order of drawing should be as follows:—Draw a square to represent the base, and an isosceles triangle on one side of it. Then, with the side of the triangle as radius, and the apex as centre, describe an arc. Cut off on this arc the



EX. 5. THE SQUARE PYRAMID.

side of the square three times and join the points. Parallels to these lines will give the glue flaps.

It should be noted that if the pyramid is to be of a given height, a little problem

in solid geometry is involved. This is shown in the diagram, where  $AB$  = given height, and  $CB$  is the length of the median of the triangular faces of the pyramid. By making  $CD = CB$ , the true shape of the triangular faces is obtained.

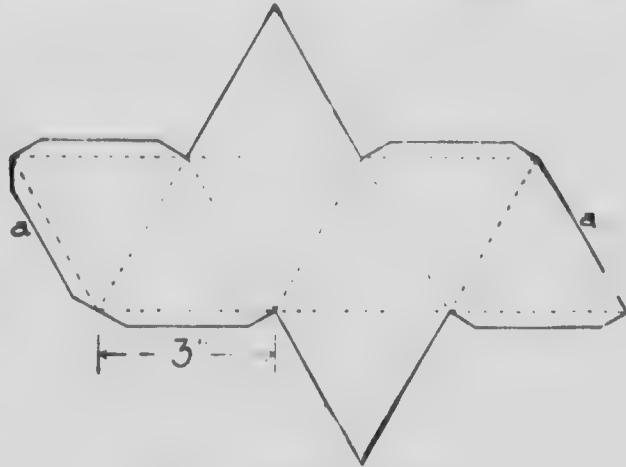
Glue up on  $a$  first and when dry, glue the remaining flaps and press the base firmly against them until thoroughly set.

## EXERCISE 6. THE OCTAHEDRON

This solid presents little difficulty in construction, but is a useful exercise. As one of the commonest crystal forms, the completed model will be found useful in the nature lessons.

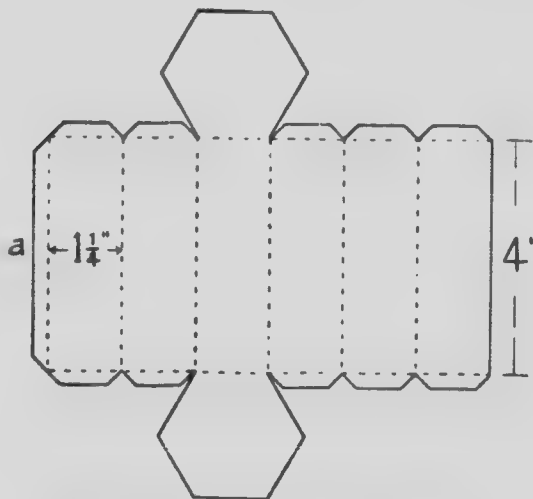
Students of descriptive geometry will also find it assist them in making its orthographic projections.

In glueing up, the order recommended in the case of the cube should be followed. Glue the flap at *a* and carry it across to the edge *a*. Hold this joint until set, and then glue two of the other flaps and press down one of the triangles. Repeat for the remaining triangle and hold until set.

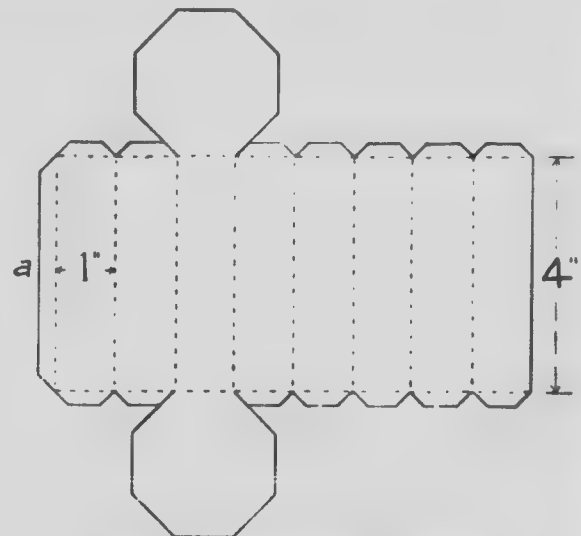


EX. 6. THE OCTAHEDRON.

### EXERCISE 7. THE HEXAGONAL PRISM



EX. 7. THE HEXAGONAL PRISM.



EX. 8. THE OCTAGONAL PRISM.

## EXERCISE 8. THE OCTAGONAL PRISM

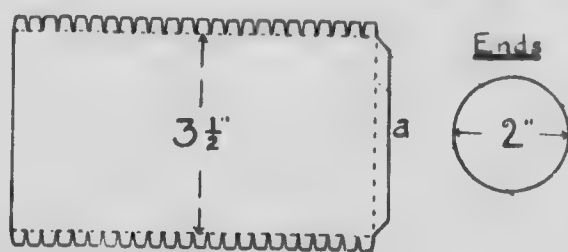
These two solids require little explanation. Draw carefully, and in gluing up note that the edge marked *a* should always be glued first. By so doing, the surfaces *without flaps* are left to be pressed down into position last of all.

This order has been observed from the cube onwards, and gives much better results than are obtained if glue flaps are left on the last surface, to be tucked in when covered with wet glue.

## EXERCISE 9. THE CYLINDER

This is a somewhat difficult model, but within the power of most pupils, and withal, interesting.

Having decided on the height and diameter of the solid,



EX. 9. THE CYLINDER.

draw and cut out two pieces of card for the ends.

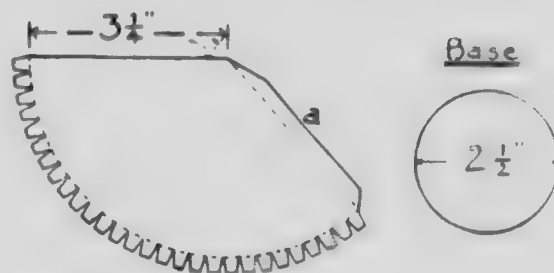
The rectangular piece will afford the pupils an opportunity of applying their knowledge of the relation between the circumference and the diameter of a circle, the length of the oblong being the *circumference* of the circular end pieces. The width is the height of the cylinder. The glue flaps are added, and scalloped on the long edges as shown. Stout manilla tag paper is best for the curved surface of the cylinder.

Glue up at *a* first, and put the ends on afterwards, one at a time.

## EXERCISE 10. THE CONE

The cone should not be attempted until the cylinder has been successfully constructed, considerable deftness being required in making a neat job of it.

The development is an interesting problem and may be described as being obtained by laying the cone on its side on the paper, and rolling it round, the tip being kept in one position. To draw the development, lay down a line equal to the length of a line from the tip of the cone to a point on the circumference of its base (the hypotenuse of the generating triangle).



EX. 10. THE CONE.

With this line as radius, describe an arc. The length of this arc must be made equal to the circumference of the base. The simplest method of doing this is to cut a narrow slip of cardboard and mark the circumference (calculated from the diameter, as in Ex. 9) upon it. By bending the slip of cardboard round the arc the length of the circumference is easily transferred to the paper.

As in the case of the cylinder, stout manilla tag paper should be used for the curved surface of this model; cardboard being difficult to bend evenly. The base should be glued on after the upper portion is set: the curved surface being held carefully in position on the circumference of the base.

Fig. 1

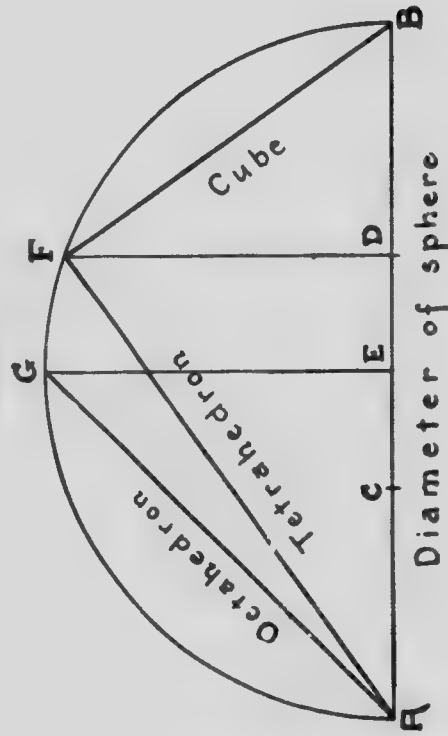


Fig. 2

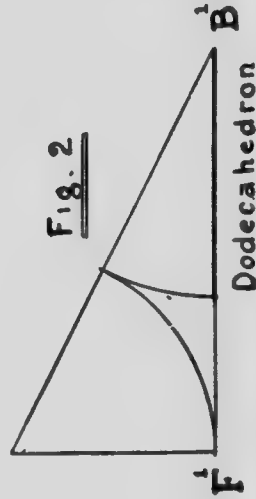
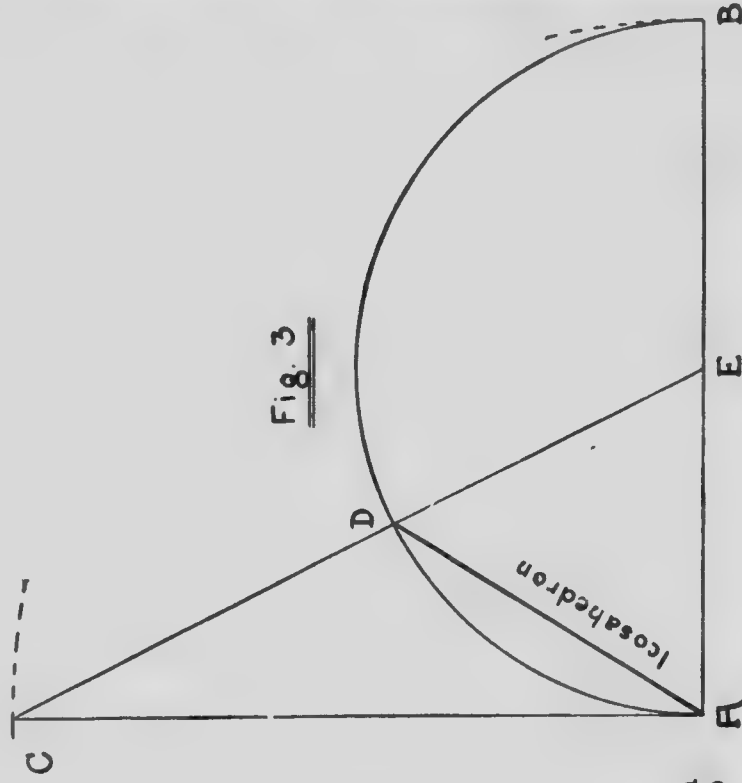


Fig. 3



METHOD OF DETERMINING COMPARATIVE LENGTHS OF THE EDGES OF THE FIVE REGULAR SOLIDS  
WHEN INSCRIBED IN A COMMON SPHERE.

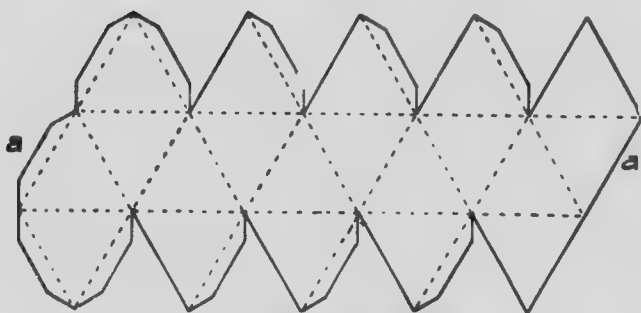
Draw  $AB$ , Fig. 1, and upon it construct a semicircle. Divide  $AB$  into three equal parts in  $C$  and  $D$ , and raise perpendiculars from  $D$  and from centre  $E$ . Join  $AG$ ;  $AF$ , and  $BF$ .

These three lines give the lengths of the edges of the Octahedron, Tetrahedron, and Cube.

In Fig. 2,  $F'B'$  is equal to  $FB$  in Fig. 1. By dividing this line in extreme and mean proportion, the length of side of the Dodecahedron will be obtained as the greater segment.

In Fig. 3,  $AC$  is drawn as in Fig. 1, and  $AC$  is perpendicular to it and of equal length. The rest of the construction is obvious.

## EXERCISE 11. THE ICOSAHEDRON



EX. 11. THE ICOSAHEDRON.

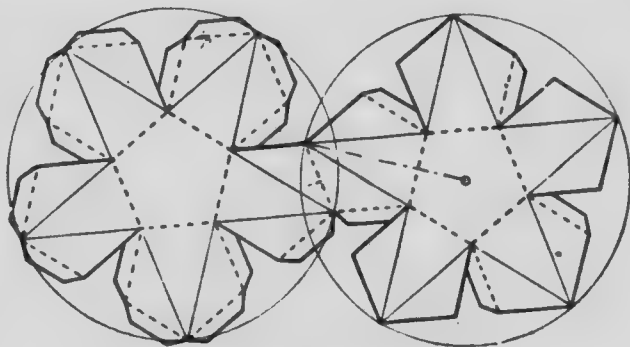
This model is quite simple in construction, but, owing to the large number of surfaces, great accuracy is necessary in the drawing and half-cutting.

In glueing up, the usual order should be followed, the flap and edge marked *a a* being fastened first.

## EXERCISE 12. THE DODECAHEDRON

The drawing is the worst part of this model, which is not nearly so formidable a problem in construction as it appears.

Commence by drawing a circle and dividing the circumference into five equal parts. By joining these alternately, the central pentagon is obtained. The construction of the other five pentagons can be readily followed, and the other half is easily drawn.



EX. 12. THE DODECAHEDRON.

Draw and cut with great care, and glue up joint by joint from the centre until the model is complete.

## CHAPTER VIII

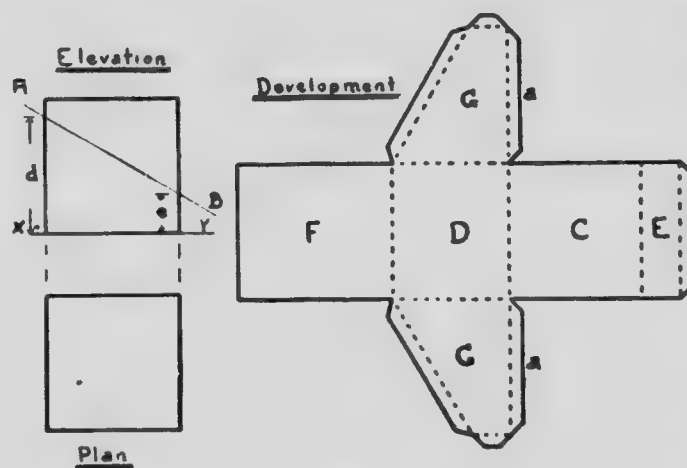
### DESCRIPTIVE GEOMETRY

IN the examples given in this chapter, the solids are shown in "plan" and "elevation," the ground line being indicated by the letters *X Y*. This is the usual method adopted in works on Descriptive Geometry, the portion of the paper above the *X Y* line being the vertical plane of projection; the portion below, the horizontal plane.

The developments are obtained from the plans and elevations, thus forming useful and practical exercises.

It should be noted that the solids are assumed to be cut in half by a "plane of section," and that one portion only is

shown ready to cut out and glue up. Both portions of the solid should, however, be constructed, although it has not been deemed necessary to show the second portion on a separate diagram. A very little thought will enable the



EX. 1.

student to construct the other portion so as to form the complete solid.

EXERCISE 1. A cube of  $2\frac{1}{2}$  inch edge cut by a plane of section ( $A B$ ) inclined at  $30^\circ$  to the horizontal plane.

Draw a square ( $C$ ) representing the lower face of the cube; add  $D$  and  $E$ , their widths being obtained from the elevation ( $d$  and  $e$ ). The faces  $G G$  are shown in the elevation, and  $F$  is equal to their longest edges.

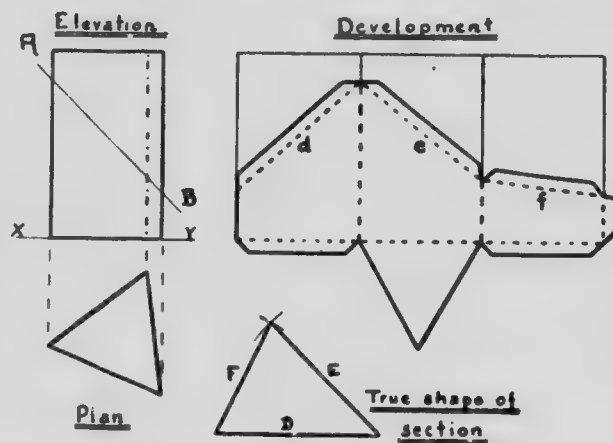
Add the glue flaps as shown, and in glueing up commence at  $a a$ , leaving  $F$  until the last.

EXERCISE 2. A triangular prism, standing on its end, is cut by an oblique plane having an inclination to the horizontal plane of  $45^\circ$  ( $A B$  in diagram). To find the true shape of the section, and construct the model.

The plan and elevation should be drawn by each pupil—the plan first—then the elevation projected from it and the section line shown. Next, draw the

development of the rectangular faces—transfer the heights of the points of intersection of the cutting plane and the angles of the prism as shown in elevation, and add the flaps and the triangular face.

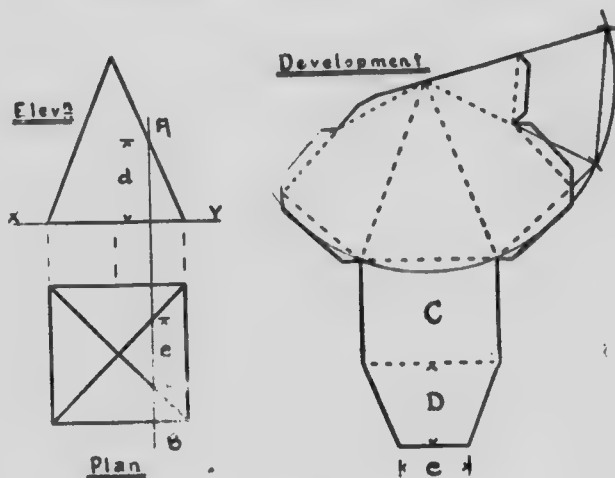
The true shape of the section is found by making a triangle with its sides equal to  $d e f$  respectively. It is better to make this piece separate from the development and to glue it on last of all.



Ex. 2.



**EXERCISE 3.** A square pyramid is cut by a vertical plane of section ( $A B$  in diagram). Find the true shape of section and construct model.

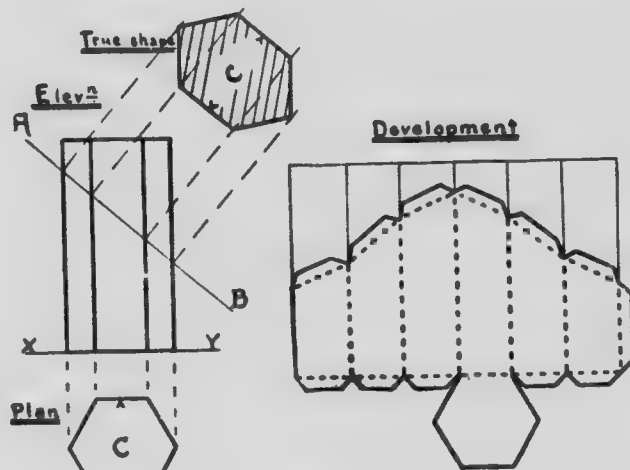


Ex. 3.

Draw rectangle  $C$  (shown in plan) — then the surface  $D$ . The rest of the drawing is easily followed if the square pyramid in the previous chapter has been made.

**EXERCISE 4.** A hexagonal prism is cut by an oblique plane inclined at  $40^\circ$  to the horizontal plane ( $A B$  in diagram). Find the true shape of section and construct model.

This exercise requires very little explanation, as it follows the lines of the triangular prism except in the finding of the true shape of section. This must be projected as shown, but in other respects the order of work is precisely as in the triangular prism.

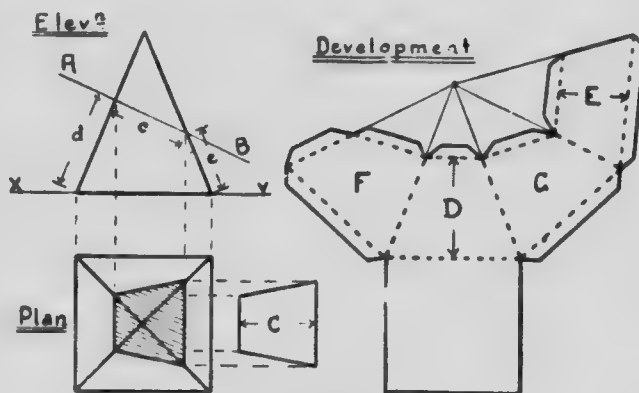


Ex. 4.

**EXERCISE 5.** A square pyramid is cut by an oblique plane inclined at  $27^\circ$ . Find the true shape of section and construct the model.

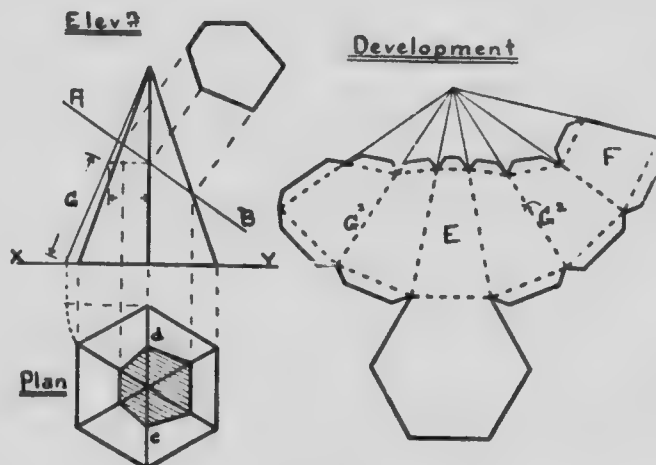
Draw plan and elevation; show section line in elevation and draw projectors (chain lines in diagram) from it to show section in plan.

Draw the complete development, then parallels to bases of two triangular faces as shown, at distances equal to  $d$  and  $e$  in the elevation.



Ex. 5.

Join their extremities and obtain faces  $F$  and  $G$ .



Ex. 6.

The true shape of the section is obtained partly from the plan, and partly from the elevation, as shown.

Glue up as before, leaving section piece until the last.

**EXERCISE 6.** A hexagonal pyramid is cut by an oblique plane inclined at  $35^\circ$ .

Find the true shape of the section and construct the model.

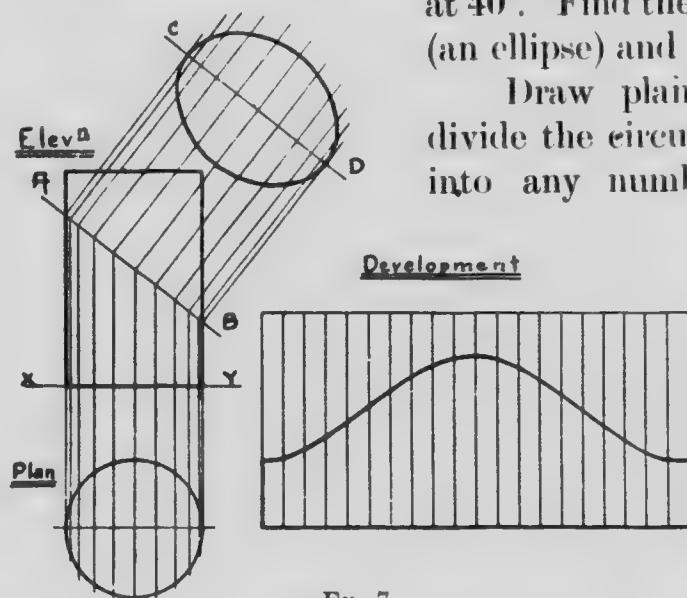
Draw plan and elevation and the line  $AB$  to show section in elevation. The dotted projectors from  $AB$  give four points in the plan of section, but  $c$  and  $d$  must be obtained by construction. The method is shown in the elevation, and explains itself.

Draw the complete development—draw faces  $E$  and  $F$ —the other faces can be drawn when the lengths of  $G^1$  and  $G^2$  are transferred from the construction in the elevation.

The true shape is projected from the elevation, the widths being obtained from the plan of the section.

**EXERCISE 7.** A cylinder is cut by an oblique plane inclined at  $40^\circ$ . Find the true shape of section (an ellipse) and construct the model.

Draw plan and elevation and divide the circumference of the plan into any number of equal parts.



Ex. 7.

Through the points thus obtained draw a series of vertical ordinates across the plan and up to the section line. From the section line erect a number of perpendiculars; make  $CD$

parallel to  $AB$  and cut off the length of each ordinate in the plan on the corresponding perpendicular to the section line. A fair curve  $A$  drawn through these points will give the ellipse.

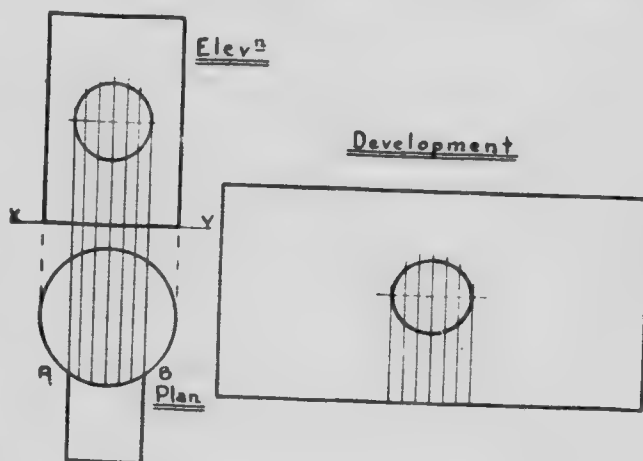
For the development, draw the rectangle; with a pair of

dividers step off distances equal to the divisions on the circumference. Erect vertical lines from these points; transfer the heights from the elevation, and trace a fair curve through the points thus obtained.

Glue flaps are required on the straight edge, as in the cylinder in Chapter VII, but it is better to do without flaps on the curved edge, and to fix the elliptical section piece by means of a strip of "passe-partout" binding. This should be snipped with the scissors at frequent intervals along one edge, and fastened to the elliptical piece first. After the ellipse has been fixed in position, the whole model may be covered with white paper to give a neat finish.

EXERCISE 8. This is a simple example of the "inter-penetration" of two solids, the larger cylinder being pierced by one of half the diameter.

To obtain the development of the hole in the large cylinder, the segment of the plan from *A* to *B* should be divided into a number of equal parts. These



Ex. 8.

are carried to the elevation, and, in turn, to the development.

After glueing up the cylinders, the smaller of them is simply pushed into the hole in the larger, no fastening being necessary.



RAFFIA WINDING.—NAPKIN RINGS, MATCH-HOLDERS, BOXES AND BASKETS.

## CHAPTER IX

### RAFFIA WORK

No manual on Educational Handwork is complete without some reference to work in Raffia : a material used for manual training purposes more extensively, perhaps, than any other except wood. The product of a Madagascar palm, it is unexcelled for toughness, pliability and resistance to decay. In form, it consists of narrow strands or blades, from two to six feet long, of a pale yellow or straw colour, which come braided into hanks weighing from a half to one and a half pounds.

Formerly its chief use in the western world was by florists and horticulturists for tying flowers, plants, etc. ; but in the search for material for handwork its great possibilities were soon recognized, and it has been widely adopted by teachers of manual training the world over.

Raffia may be used with advantage, in some form or other, from primary to advanced grades. For beginners, raffia winding is very suitable. Later, raffia and canvas, raffia weaving, raffia braiding, raffia sewing, etc., may be taken up.

Raffia may be obtained from the school supply houses either in its natural colour or dyed in many attractive hues. Some teachers, however, may prefer to dye it for themselves or may wish the pupils to have the experience. For this purpose, some of the household dyes sold in the stores may be used, but as these are nearly all aniline preparations, it is better to follow the example of the Persians, who refuse to



RAFFIA WINDING AND SEWING. — OBLONG, CIRCULAR AND ELLIPTICAL FRAMES; TABLE MATS; CANTAS AND RAFFIA NEEDLE CASES.

allow the use of aniline dyes in their famous rugs, and use vegetable dyes exclusively.

In many districts, old housewives still have recipes for good dyes made from plants, bark, berries, etc., which are excellent for colouring raffia. The following are a few simple formulas for those who may wish to try their hand at dyeing the material instead of purchasing it ready dyed from the stores :

A solution made by soaking the green outer covering of walnuts or butternuts gives a rich brown. Brown can also be obtained by a decoction of logwood extract, the colour varying according to the strength of the solution. The raffia is steeped in the solution for about a quarter of an hour and then hung up to dry.

For some colours a "mordant" is required to make the colours adhere to, or enter, the fibres of the raffia. To dye raffia red, it must first be soaked in a solution of potassium bi-tartrate (cream of tartar), which acts as a mordant, and then steeped in a solution of cochineal.

For yellow, an alum mordant must be used, the raffia being soaked for about a day in a solution of common alum in water. A bath composed of extract of fustic and water is then prepared, and the raffia is boiled in this for fifteen minutes.

When mordants are used it is best to rinse the raffia in clean water after dyeing, to prevent the colour coming off on hands and clothing.

#### RAFFIA WINDING

For beginners, the winding of raffia upon cardboard or pasteboard forms is to be recommended. As the whole of the



cardboard is covered with a good or colour will serve, and old packing boxes can be utilised with advantage.

To prepare for the work of a class, a hank of raffia should be untwisted, soaked in water for a few minutes, and then hung up to drain.

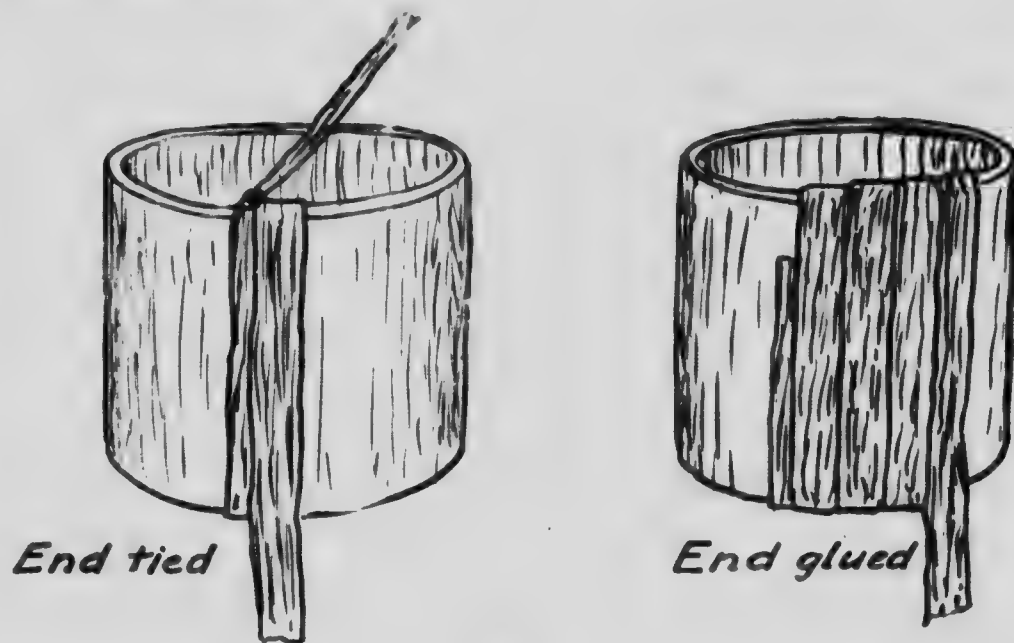


FIG. 1.

An excellent first exercise is a napkin ring, the form being a piece cut from a postal mailing tube with a fine saw. If mailing tubes are not available, a plain strip of stout cardboard may be rolled into a cylindrical form and the ends fastened together with liquid glue. To commence the winding, a strand of raffia should be taken by the root end and straightened by being passed between the finger and thumb. The first turn on the cardboard ring may be fastened with a dab of glue, or, better still, by tying with a square knot

(see Chap. V), leaving an end of a couple of inches in length (see Fig. 1). Turn after turn is then wound on, each turn just meeting the previous one, without overlapping. When the cardboard form has been completely covered by the raffia, a second layer is wound on; care being taken this time to overlap the joins between the first winding. When a strand of raffia is nearly used up, a second one should be tied firmly to it with a square knot; the knot being so arranged as to be inside the ring when wound.

This simple exercise is capable of many variations in finish, or may be left plainly wound as described. A simple and pleasing decoration for very young pupils is formed by tying the ring round the middle with a strand of coloured raffia or a piece of ribbon. Another favourite method for beginners is to finish the ends of the ring by buttonholing the edges with coloured wool or yarn. Advanced pupils may also weave attractive patterns with coloured raffia and a tapestry needle, or may work monograms upon the face of the napkin ring with wool or silk (see half-tone illustrations).

Arising out of the napkin ring, useful match-holders may be made. The body is made just like the napkin ring, and then sewn to a broader base. The base is shown partly covered in Fig. 2, and consists of a ring of cardboard wound with raffia of some contrasting colour. As young pupils find it difficult to cut out these rings, it is a good plan to have them

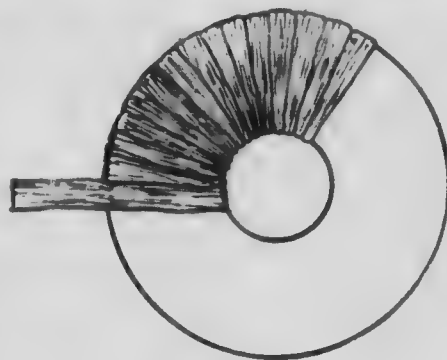


FIG. 2.

cut by senior pupils. The circular hole in the middle is formed with a "wad-cutter," to be obtained for a few cents at the hardware stores. Armed with a hammer or mallet, and a



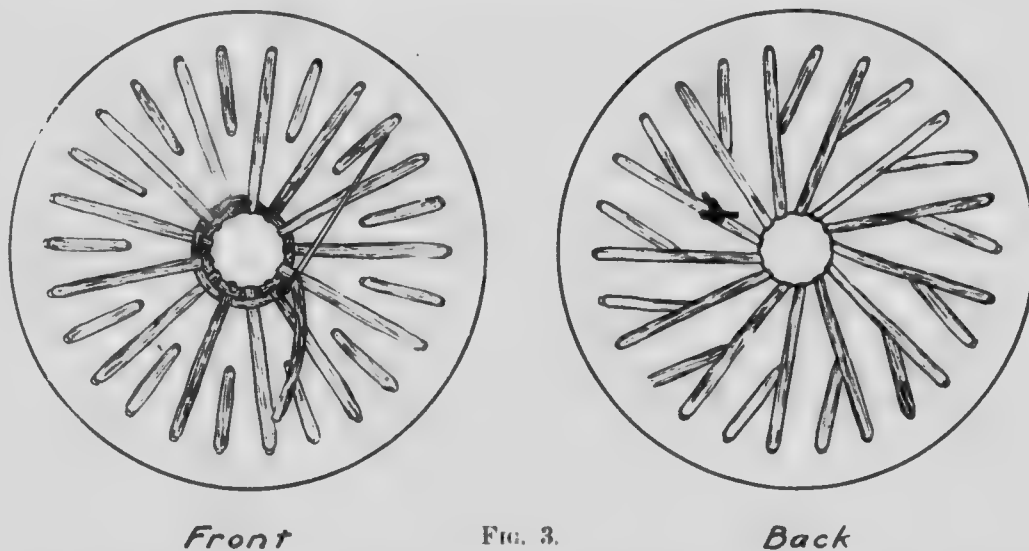
FIG. 2a. A SIMPLE RAFFIA-COVERED BOX.

block of wood for a support or pad, a small boy can cut out the centres with a wad-cutter quite easily.

By increasing the height of the body of the match-holder, a hat pin holder may be constructed, and forms a pleasing present for mother or big sister.

The illustration shows other uses for small rings wound with raffia, several of them being joined together by "Battenberg" stitching, to form a table mat and a whisk-holder.

A still further development of the same idea is seen in the illustrations of boxes of various kinds. Some are without covers, but the majority have them woven in some pleasing design. The simplest form of cover is made in the same way



as the base for the match-holder, the hole in the centre being filled in with a spider's web pattern in coloured raffia. The cover is hinged to the box by sewing with the same material. The insides are lined with coloured paper, cotton or silk, according to circumstances. (See Fig. 2a.)

Various table mats may also be made by covering cardboard as described.

If a woven pattern is desired for the top, care must be taken to start with a proper number of spokes radiating

towards the circumference. Fig. 3 shows the method of work, the circle being first divided into an odd number for the long spokes, the half spokes being placed between. It will be seen that an odd number of long spokes is necessary so as to change the order of "under and over" every revolution of the weaver. Commencing at the centre with a blunt needle threaded with a strand of raffia, the weaver is passed alternately under and over the spokes until the outer holes are reached. The border is formed by winding raffia of some other colour through the spoke holes and round the rim (see half-tone illustrations);

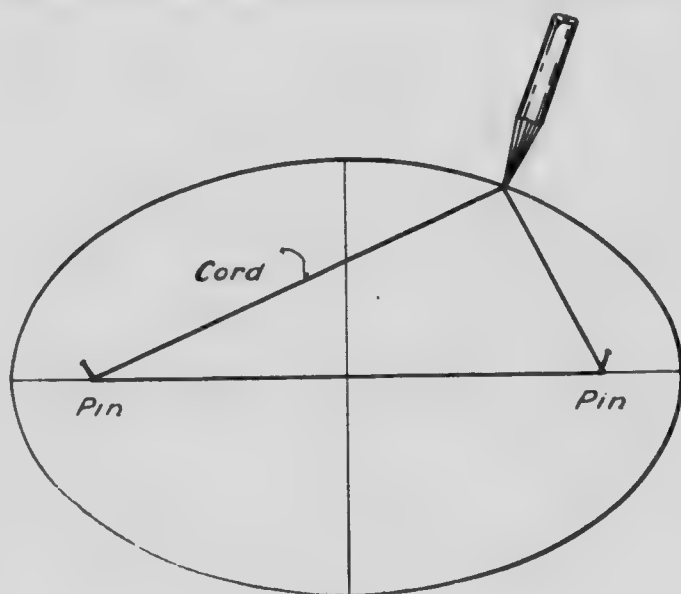


FIG. 4.

the spaces between the little triangular patterns thus formed being filled by weaving a number of strands of some contrasting colour round and round the circle to form a full, raised edge.

Later on, when the method of drawing an ellipse has been

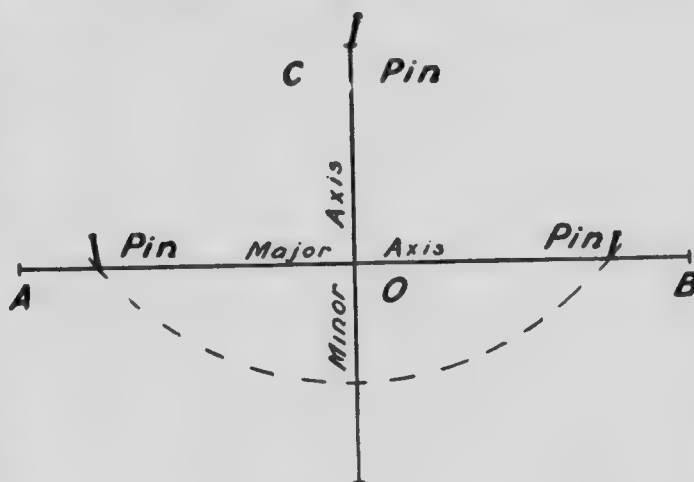
mastered, elliptical boxes may be constructed in the same manner. (See Fig. 4*b*.)

Attractive covers may also be made by winding a piece of No. 2 reed with plain raffia and sewing it into a circular form with coloured raffia or yarn.

Another good exercise in winding is the making of picture frames, the simplest being a circular one made like the base of the match-holder. Care must be taken to keep each turn of the raffia on a radial line; or, as it may be put to young pupils, "pointing to the centre."

An elliptical, or so-called "oval" frame, is also a favourite one and presents no difficulty in winding. The ellipse should be drawn with

pins and string or thread, as shown in Fig. 4. Fig. 4*a* shows the method of finding the position of the pins (the foci of the ellipse). With radius *O A* and centre *C*, cut off the two points as shown on major axis. In-

FIG. 4*a*.

sert pins at these two points and also at *C*, and tie a piece of thread round them. Take out pin at *C* and substitute a pencil and draw the curve as shown in Fig. 4.

For the decoration of these frames, a method offering a wide scope for originality is to braid a narrow plait and apply it in various patterns by sewing on the face of the frame. A three-strand plait, each strand having two pieces of raffia in it, is quite heavy enough for this appliqué ornament.

The edges of the opening and of the outside may also be buttonholed or oversewn with coloured yarn with good effect.

Rectangular frames require special treatment at the corners, for if these are left square the raffia slips back from



FIG. 4b. AN ELLIPTICAL RAFFIA COVERED BOX.

the angle. To overcome this the cardboard should be rounded

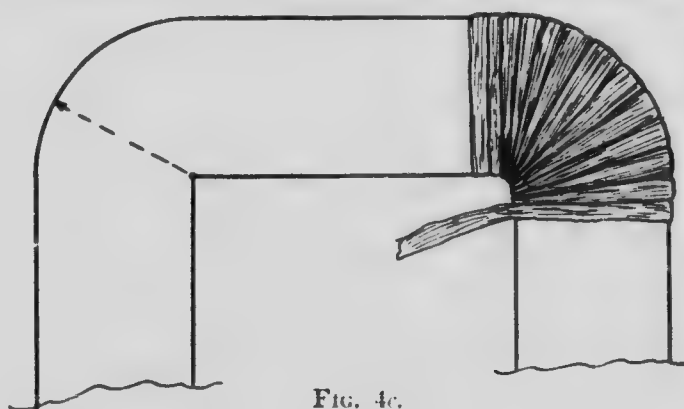


FIG. 4c.

on the outer angle as shown in Fig. 4c. The inner angle is left square, but a rounded effect is produced by the overlapping of the raffia in winding.

In all the frames the pictures may be attached to the back by a few dabs of liquid

glue, or a back of plain cardboard may be sewn on with a fancy stitch, leaving an opening through which the picture may be slipped.

#### RAFFIA AND CANVAS

Many useful articles may be made of coarse canvas by weaving various patterns in it with coloured raffia, using the blunt, large-eyed tapestry or rug needles. Needle books, pin cushions, sachets, mats, blotter covers and bags are articles suitable.

This forms an excellent introduction to needle work; for many stitches, such as oversewing, hemming, seaming, button-hole, herring-bone and blanket stitch can be easily taught in it. The large, free motions necessary for these stitches in raffia canvas work come very properly as a preliminary to the finer work of actual sewing, for young pupils.

#### RAFFIA WEAVING

Weaving, the great primitive occupation, is always attractive to children in all its forms, and raffia offers a convenient and suitable medium for its practice.

The box covers described earlier in this chapter are a good introduction to weaving for older pupils, but exercises in weaving on looms or frames will be found an interesting and profitable study for quite young pupils.

Simple looms or frames can be purchased for school purposes; or, if a woodworking department is at hand in the school, frames can be made from a few slats fastened together at the corners. Failing this, a slate frame will do very well, and should be prepared by driving a row of small brass pins



across the end pieces, about a quarter of an inch apart. Round these pins, strands are tightly stretched to compose the warp. The weft is inserted by means of a bodkin, or other long needle, such as a kindergarten weaving needle, with a large eye, alternately over and under from side to side until finished. When the weaving is completed, the loops of the warp are lifted from the nails, and the mat is complete. If a neater finish is desired the edges may be oversewn or stitched with coloured yarn.

Such a mat is greatly prized as a furnishing for a doll's house or may even be used as a table mat. Or, two such mats joined by loops of yarn or raffia at the back will make an effective book cover. A good finish may be obtained by forming a raised border by laying in two or three strands of raffia under the button-holing or oversewing.

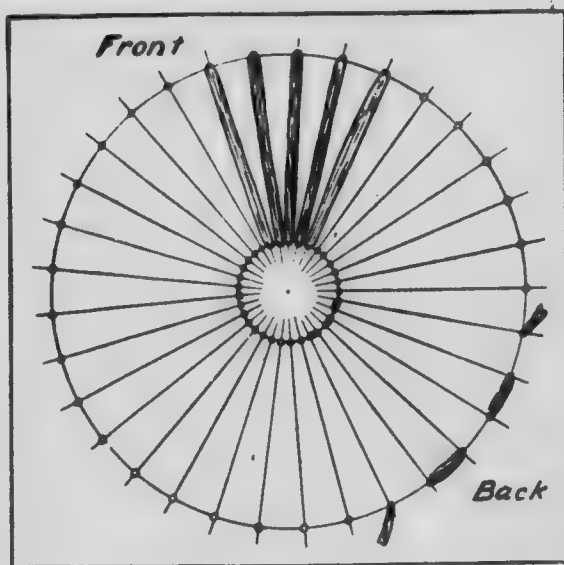


FIG. 5.

A nice circular mat for the table may be formed upon a stiff piece of cardboard. Fig. 5 shows the preliminary stage, and Fig. 6 the finished mat. In marking out the cardboard, an odd number of spokes must be chosen. Care is necessary, as in all forms of weaving, not to draw the weft too tight; while at the same time it must be pressed

snugly against the preceding row. When the weaving is completed, the card is removed from the back and the outer edge finished with a broad band of blanket stitch or button-holing. Children find these stitches rather difficult for the central hole, and therefore simple oversewing should be used inside.

Cushion covers for hammocks, canoes, and other outdoor uses are exercises which appeal to senior pupils. For their construction, a simple frame, such as that shown in Fig. 7, is necessary; also a long, flat needle of some smooth hardwood. The warp is stretched tightly from end to end of the frame and held in the saw cuts, four to six inches of raffia being left outside the frame on each end. The weft is then inserted by means of the long wooden needle, and when completed, the whole piece is lifted from the saw cuts and a second one woven. The ends are formed into a fringe, and in sewing together to form the cushion cover the two halves are so placed as to form a fringe on all four edges of the cushion. Suitable decorations are formed by weaving in bands of raffia, five or six strands in width, of different colours. If a band border is required, strands of the necessary colour should also be laid in the warp. For large cushions, several pieces of raffia should be used for the weavers.

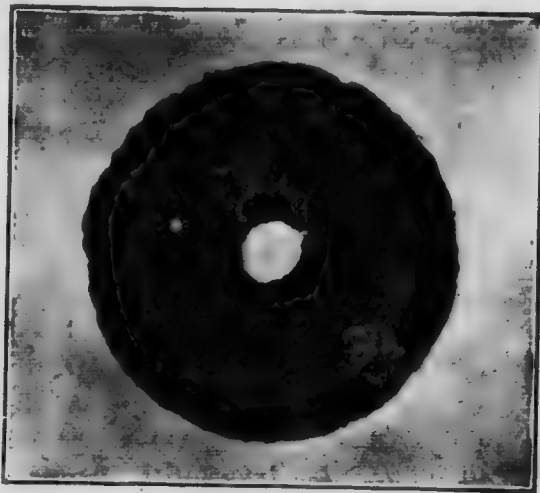


FIG. 6. A RAFFIA TABLE MAT.

Before leaving the matter of weaving, it may be well to point out that in the author's experience it has been found

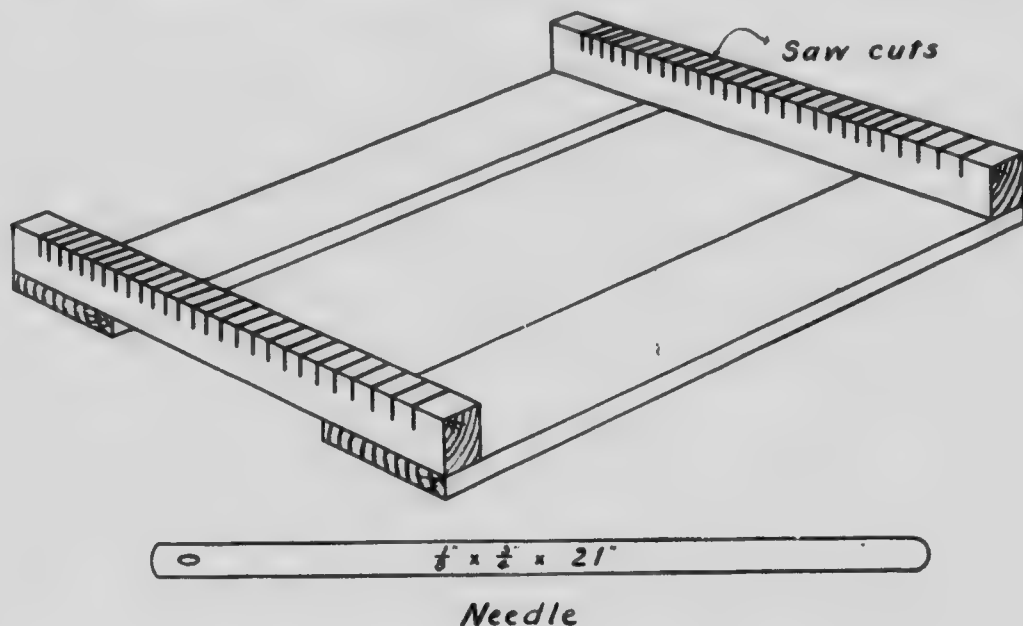


FIG. 7.

that children are usually satisfied with one weaving example, the process being somewhat monotonous and full of repetition.

#### RAFFIA BRAIDING

Braiding was referred to incidentally as an applied decoration for the frames which were made by winding raffia upon cardboard, and a few hints as to the method of procedure in teaching braiding or plaiting are now given.

Commence with a simple three-strand braid, taking three, six, or nine strips of raffia, according to the size of braid desired. Tie these firmly together by an overhand knot and

pin them securely to the edge of the desk, the window sill, the dado moulding, or other convenient place. Divide the strands into three portions and braid evenly.

When a new strand requires to be inserted, the pieces should not be joined by tying, but the new piece should be laid in as shown in Fig. 8. After a turn or two, the new piece will be firmly held, and the ends may be cut off close to the braid. Braids of four, six, eight, ten and twelve strands may afterwards be taken up, and will present no difficulties after the first few rows.

After a pupil has prepared five or six yards of braid, several uses may be made of it. One of the simplest is to form a mat by sewing the braid together to form a circle or ellipse. The edges may be buttonholed or finished with loops of braid in a fancy pattern. Dolls' hats, baskets and trays may be constructed in the same manner, the various curves being obtained by sewing the braids on to the edge of the previous ring instead of on the side, as in the flat portions. (See Fig. 9.)

Very pleasing effects may be obtained in braiding by using strands of raffia of different colours.



FIG. 8.

In sewing raffia braid to form hats, baskets, etc., care must be taken to conceal the stitches as much as possible,

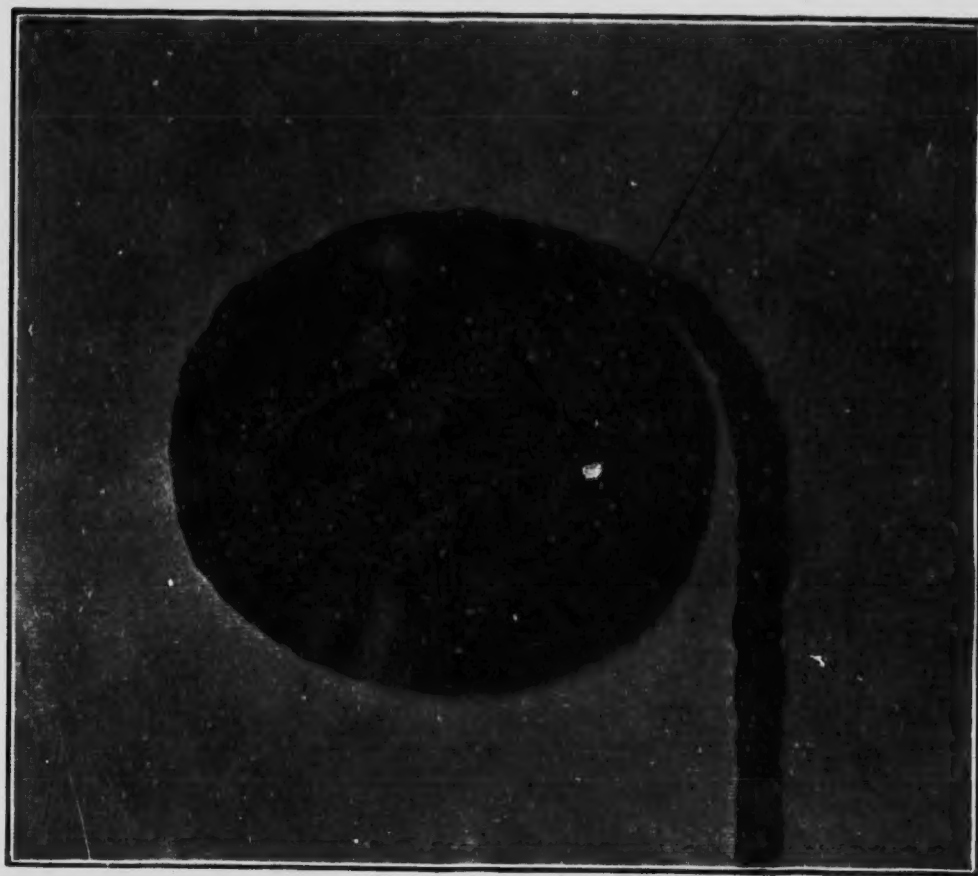


FIG. 9. STARTING A HAT IN RAFFIA BRAID.

and to sew each turn firmly to its fellow. Use a No. 5 needle and No. 20 thread.

#### RAFFIA NETTING

One example only of raffia netting is here given, a simple bag. (Fig. 10.) The method of starting the exercise is shown

in Fig. 11, where the strands of raffia are looped over a ruler and tied with a simple overhand knot. After the netting and



FIG. 10. A BAG OF RAFFIA NETTING.

fringe are completed, a lining of cotton and a reeving string of cord or twisted raffia, make a good finish.

Many teachers find the covering of bottles, etc., with raffia netting to be interesting and useful, but no special instruction is necessary for such work.

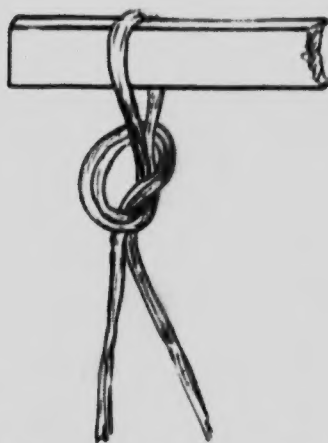


FIG. 11a. THE KNOT FOR BAG.

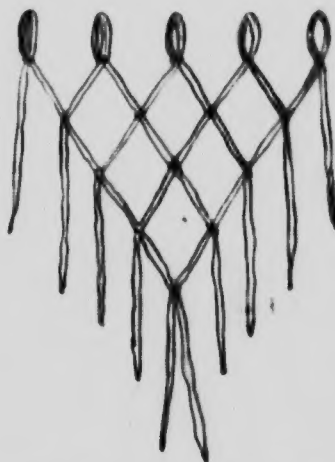


FIG. 11b. FIRST STAGE OF NETTING.

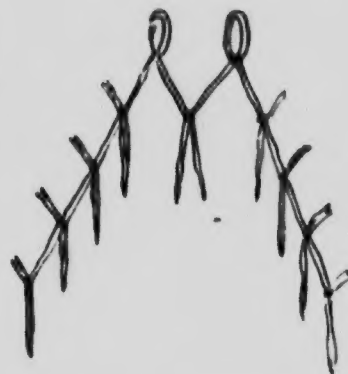


FIG. 11c. JOINING THE ENDS.

#### SEWING WITH RAFFIA

The limits of this volume will not allow of any detailed consideration of many other uses of this attractive material, but mention must be made of raffia embroidery. With a ground work of canvas, coarse linen or serge, raffia is an excellent medium for the embroidering of ornament for many useful articles, such as cushion covers, bags, handkerchief and other cases.

Almost any pattern suitable for drawn thread work may be used for raffia, the ordinary frame for stretching embroidery and drawn work being used. The work is not difficult, and forms a pleasing variation of the ordinary sewing for senior pupils.

